Alberta Research Council
1984 Annual Report

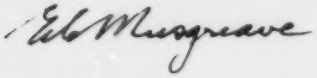
The Alberta Research Council is a crown corporation of more than 500 employees promoting responsible economic development in Alberta through a broad range of research in science and technology — Industrial & Engineering Research, Advanced Technologies, Applied Sciences, Oil Sands, Coal and Natural Resources. The Alberta Research Council is located in Edmonton and has offices in Calgary, Devon, Red Deer, Nisku and Lethbridge.

Letter of Transmittal

To The Honorable Peter Lougheed
Premier of the Province of Alberta

In accordance with the requirements of the Alberta Research Council Act, I have the honor to present to you the Annual Report of the Alberta Research Council for the calendar year 1984.

Respectfully submitted,



Eric C. Musgreave, M.L.A.,
Chairman, Alberta Research Council

March 1985

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Cover:
The Alberta Research Council is exploring ways to extend the growing season of crops through low temperature microbiology.

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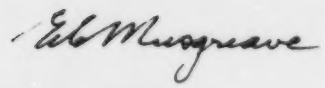
Chairman's Message

It is a pleasure for me on behalf of the Board of Directors to introduce Robert Stewart, O.C., Ph.D., F.R.S., F.R.S.C., as President of the Alberta Research Council, a position he assumed in February 1984. Dr. Stewart's previous position was Deputy Minister of Universities, Science and Communications in British Columbia and prior to that was Director General of the federal Institute of Ocean Sciences at Patricia Bay, near Victoria. He has led a distinguished career in science at the national and international level and we welcome back this native of Alberta.

I also welcome four new members of the Board: Dr. R.K. Kerr, Manager of Technical Services, Alberta Energy Company Ltd., in Calgary; Mr. R.O. Lindseth, President of Teknica Resource Development Ltd., in Calgary; Dr. M.A. Ward, Vice-President of Research at the University of Calgary; Mr. R.R. Watt, Group Vice-President, Transmission, at Northern Telecom Canada Ltd., in Edmonton.

Finally, with great respect and appreciation, I bid farewell to Board members who so ably contributed to the Alberta Research Council in recent years: Mr. Bev Brooker, President of B.W. Brooker Engineering Ltd., in Edmonton; Dr. Keith Cooper, former Vice-President, Research and now Professor in the Department of Physiology, at the University of Calgary; Dr. Robert Hardy, Chairman of Hardy Associates (1978) Ltd., in Edmonton; Mr. Marshall Williams, Chairman and President of TransAlta Utilities Corporation, in Calgary.



Eric C. Musgreave, M.L.A.,
Chairman, Alberta Research Council

President's Report

I am pleased to report on the first year of my experience as President of the Alberta Research Council.

During 1984 some notable results became visible — the fruits of initiatives which had been taken in previous years. Fewer new thrusts have been generated within the Alberta Research Council this year, although initiatives from outside the organization certainly will affect us. I believe we have made some substantial progress, however, in dealing with external agencies, in particular the private sector.

Foremost among our achievements was the increase of our operations in Calgary. This initiative will change the way in which our services become available in southern Alberta. Up to 15 staff will eventually have moved from Edmonton as part of this initiative and we plan to recruit another 20 or 30 staff in Calgary. Dr. David Mitchell, Vice-President of the Industrial and Engineering Research Division, has been designated our Regional Vice-President for southern Alberta.

One of the factors behind the decision to make this move is our need to support a flourishing high technology industry related to all facets of exploration in the petroleum industry. The Alberta Research Council's contact with industry in Calgary also has increased with the number of joint research projects we have undertaken. Finally, we note some large high technology manufacturing initiatives are now underway in that city, including Northern Telecom's Business Products Division and the commercial development of Novatel's cellular telecommunications systems. We hope to gain mutual benefit from an association.

A second part of this initiative is our development of a new research program called, Advanced Technologies. Staff for the program will be recruited in Calgary. The Advanced Technologies program will address productivity and profitability in manufacturing processes, using techniques such as computer aided design (CAD) and computer aided manufacturing (CAM). Some of the thrusts under consideration for this program could be development of software engineering and programs to aid planning, scheduling and decision making associated with manufacturing operations. Artificial intelligence for decision making also could be considered for such areas as forecasting weather patterns, movements of ice and applications in seismic and exploration industries.

Another way we have been able to contribute our support to Alberta industry has been our participation with Bell Northern Research in an industry survey and business plan to develop an electronic products test centre. In response to the plan, the Government of Alberta selected the Alberta Research Council to develop the $10 million centre, the first of its kind in western Canada. The centre will help manufacturers develop credible products to meet international standards as they penetrate and compete in Canadian and world markets, particularly in the advanced technologies industries. This test centre will occupy 2230 square metres of space in the new Alberta Research Council building under construction in south Edmonton, and also will include 9300 square metres of adjacent land to be designed as an open field test site for electromagnetic interference testing.

A major announcement during the year, which holds great potential for future industry in Alberta, was our contract signed in November with BIO-FROST Inc., of Hamilton, Ontario, to develop a commercial production process for an ice-inducing bacteria used in snow making. BIO-FROST's parent company, Advanced Genetic Sciences Inc., of Berkeley, California, has developed and tested this technology on a limited basis. The Alberta Research Council will be developing technology to produce the ice-inducing product on a commercial scale. This contract is significant to the Alberta Research Council because it will be the first for

the new advanced computerized scale-up facilities in the biotechnology pilot plant at the new research complex in south Edmonton. This project also marks the first time funds from the National Research Council's Program for Industry/Laboratory Projects (PILP) have contributed to a project with a provincial research organization. The new biotechnology pilot plant has already attracted this major United States biotechnology company to Alberta with promise of future investment, and we hope it will attract even more industry in the future.

During 1984, the coal analytical laboratory and the Coal Technology Information Centre moved to the new research centre in Devon, southwest of Edmonton. The Alberta Research Council is the main tenant in this centre, shared with the federal Coal Research Laboratory of the Canada Centre for Mineral and Energy Technology, Department of Energy, Mines and Resources, and a private organization, the Coal Mining Research Centre. The larger scale, high pressure work is expected to move from its temporary quarters in Nisku to the Devon research centre in 1985.

Efficient upgrading of hydrocarbons from oil sands and heavy oil deposits to marketable fuel is of major importance to Alberta's energy industry. A new program was started in 1984, jointly sponsored by the Alberta Research Council and the Alberta Oil Sands Technology and Research Authority. Under the program, we are investigating improvements to existing coking technology as well as to new hydroprocessing catalysts and processes.

Based on experience in provincial pavement impact research over the past decade, some of our civil engineers were selected to take a leading role in a study on the impact of various truck loads on our roads and highways across the country, towards achieving uniformity in truck weight and dimension regulations across Canada. During the year, 13 test sites were set up throughout Canada in preparation for the start of actual testing in May 1985.

The first in a series of public lectures by internationally recognized scientists and engineers, sponsored by the Alberta Research Council as a 75th Anniversary gift in 1983 to the University of Alberta, took place in March. Dr. James Ham, of the University of Toronto, gave the Robert M. Hardy 75th Anniversary Lectureship in Engineering on the topic "Technology, Work and Engineering." Also in March, Dr. John Polanyi, of the University of Toronto, gave the John A. Allan 75th Anniversary Lectureship in Science on "How Discoveries Are Made, and Why It Matters." In November, Dr. John Dillon, a world leading agricultural economist from the University of New England in Armidale, Australia, gave the Nathaniel H. Grace 75th Anniversary Lectureship in Agriculture on the topic "Technology vs. Hunger: Programs and Prospects." This year was the first of five for these three public lectureships. I was pleased to see how well received they were by the university and the general public.

Although our work at the Alberta Research Council largely depends on teamwork, it is a pleasure on occasion to recognize individuals for outstanding achievements. One of those achievements was the appointment by the Board of Directors of Dr. Toshi Kaneda to the distinguished position of Research Fellow.

The process for selection to Research Fellow includes reviews by eminent external referees to confirm that the research of the candidate has scientific quality of international standard. It is deserved recognition for Dr. Kaneda, who has contributed 25 years of outstanding work to the field of microbiology in Alberta. As a Research Fellow, Dr. Kaneda plans to concentrate his research activities in the field of lipid biology and enzymology.

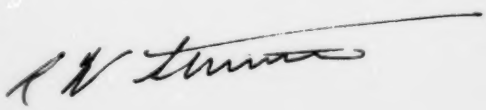
Other outstanding achievements include patents granted during the year. Canadian and United States patents were issued to Dr. Zac George, of the Chemistry Department, on his process for regenerating Claus catalyst once it has been used for "sweetening" sour gas. A United States patent was issued to Dr. Petre Toma, of the Oil Sands Research Department, and to a research scientist at Texaco Canada Resources Ltd., for their invention of a filter to ease the problem of sand clogging production wells during in situ oil sands recovery operations. Another United States patent went to Dr. Eddie Isaacs and Dr. Dan Prowse, of the Oil Sands Research Department, for their process "Use of Surfactants to Improve Oil Recovery During Steam Flooding."

I also would like to acknowledge Dr. Tom Christison, of the Civil Engineering Department, for winning the President's Medal from the Roads and Transportation Association of Canada for his outstanding research paper.

Many of the more difficult problems we have had to deal with in recent months have been associated with our successes. For example, having developed a sand exclusion device for Texaco, we have been heavily involved in trying to find a suitable Alberta manufacturer. Having developed a front-line gas separation membrane, we are struggling with the problem of getting it into the market. Having developed a world class coal research centre, we are faced with the problem of how to deal with United States concerns who wish to take advantage of our expertise, without compromising the ownership of intellectual property we have created for Alberta Energy and Natural Resources. These are the problems we are glad to have to deal with. There will be more!

I would like to recognize the dedication and efforts of Dr. Robert Green, who served as Deputy President for six months until my appointment. He did not act merely as a caretaker. Many important initiatives were taken during this period. As always, he served the Research Council well.

Finally, I sincerely appreciate the support and advice which the Board of Directors has given me.



Robert W. Stewart
President

Industrial & Engineering Research

To improve assistance to small- and medium-sized industry and increase the Alberta Research Council's presence in southern Alberta, part of the Industrial and Engineering Research operations moved to Calgary.

Introduction

One of the Alberta Research Council's missions is to conduct research in support of the province's economic development, particularly industrial development. In response to that mission, the Industrial and Engineering Research program interacts directly and mainly with industry.

Review of 1984

Industrial development

The Alberta Research Council solves short-term industrial problems, supplies technical assistance and information, and puts Alberta's small industrial entrepreneurs in contact with those parts of the Alberta Research Council or other agencies most able to assist them.

Short-term assistance — from several hours to several days — includes providing technical and engineering assistance in solving industrial problems, providing access to computerized information systems, and advising on procedures for research and development of new products.

The Industrial Development Department also promotes and administers the National Research Council's Industrial Research Assistance Program (IRAP) in the province. In 1984, the IRAP funding in Alberta increased by 35 percent. The IRAP-H program, which provides salary support to companies interested in hiring science and engineering students to help solve short-term technical problems, resulted in the hiring of 48 students, compared with 39 the previous year. Under the IRAP-L program, small- and medium-sized companies are eligible for financial assistance in solving technical problems or fulfilling testing requirements by contracting the work to appropriate laboratories, institutes or consultants. The IRAP-L projects increased to 114, compared with 95 a year earlier. The IRAP-M program offers salary support to companies for technical personnel engaged in short-term scientific or technical research projects. The IRAP-M projects increased to 32, from 27 the previous year. The IRAP-P program offers financial assistance to companies involved in long-term applied research projects of high technical merit. Those projects increased to 14 in 1984 from 10 in 1983.

During 1984, research engineering staff responded to some 5400 client contacts (including IRAP projects), and the industrial assistance covered many types of activities and problems. The following are a few selected examples.

Canadian Mountaineering Equipment Ltd. is a Calgary-based manufacturer of hiking and mountain climbing bags and equipment. With support from the National Research Council's IRAP-L program, the company was able to hire an industrial designer from the University of Calgary to design its own camera bag line. The company is now marketing this bag in Canada, and has recently completed negotiations for developing a European market. The Alberta Research Council has assisted the company in establishing inventory and production control systems, and used its new CAD (computer aided design) system to design a new plant layout.

Faced with the need to improve its production methods to meet increased demand, Meridian Fireplace Canada of Edmonton received a full range of support from the Alberta Research Council. Researchers reviewed the original plant layout, the complete flow and process of materials and products, and produced a new plant layout design. With this new plant layout, it is possible for the company to employ as many as 60 people, up from its current employment level of 22. With support received under the IRAP-L program, the company was able to obtain CSA (Canadian Standards Association) approval for two of its products.

Actiplast Industries Ltd., a Calgary manufacturer of fiberglass reinforced plastic products and building supplies, was interested in responding to a tender for supplying the Grande Cache Correctional Institute with fiberglass reinforced plastic furniture for cells and common areas. The firm lacked the engineering capability, however, to develop a design for the furniture. With support under the IRAP-L program, Actiplast was able to secure the services of a consulting engineer to design the prototype furniture. The company was successful in its bid on the $420 000 Grande Cache project, and is now manufacturing the furniture.

Materials and processes

The Alberta Research Council has the expertise and equipment to perform a wide variety of physical and chemical

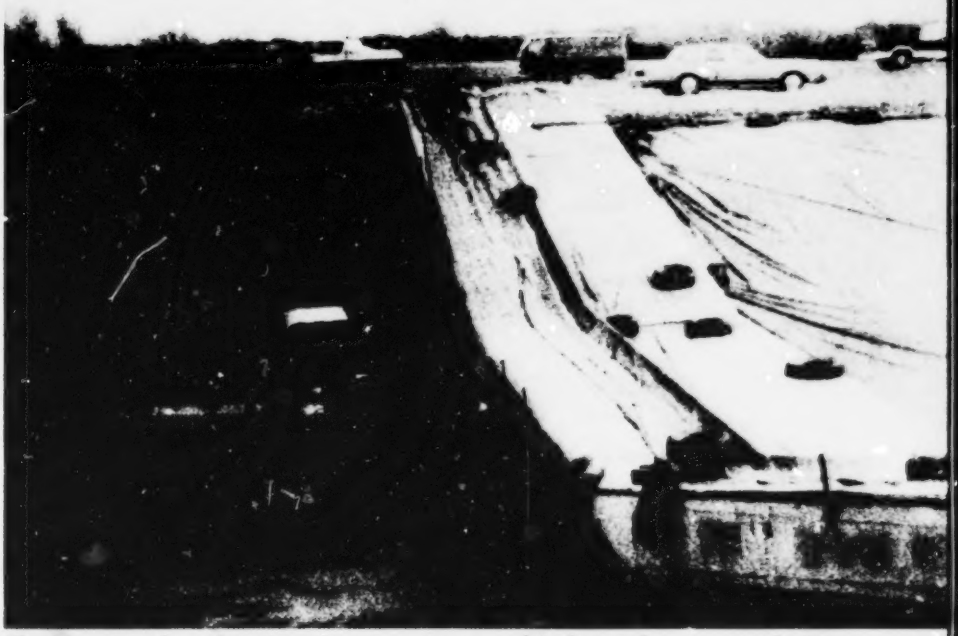
A Calgary firm designed its own line of camera bags with the support of the Industrial Research Assistance Program.

tests on materials and products to help Alberta manufacturers with technical problems.

During 1984, work continued on the development of the membrane technology for separation of industrial gases. There was technical progress with the separation of carbon dioxide and hydrogen sulfide from sour natural gas, and gas produced from carbon dioxide flooding of oil bearing formations to stimulate oil production. An independent consultant's study verified in-house evaluations that, compared to conventional processes, there are technical and economic advantages when the membrane process is used in selected applications for the separation of hydrogen, carbon dioxide and hydrogen sulfide from complex gaseous mixtures. Alberta Helium Limited of Calgary has been active in conducting pilot-scale testing as a technology transfer step towards industrial commercialization.

Heavy oil and bitumen are too viscous to be transported by conventional pipeline. The most common solution for reducing the viscosity to acceptable levels is to dilute the oil with lighter hydrocarbons. Researchers have been studying methods for reducing viscosity without using the expensive lighter hydrocarbons. One method is to disperse the oil in water and then transport the resulting emulsion. The behavior of such emulsions has been studied under long-term pumping using a laboratory scale pipeline. Ten tests were completed in 1984 with Cold Lake crude oil.

The Alberta Research Council provided plastics research and testing services to Alberta Environment, other government departments, consulting engineering firms and private companies. For instance, the Research Council tested membrane liner materials for both new and existing installations on behalf of Alberta Agriculture and Alberta Public Works, Supply and Services. The comprehensive program of quality assurance for the liner materials, and the equipment developed for the installation of liners, has given Alberta Environment the expertise to take a leading role in the technology of lining irrigation canals. The Alberta Research Council also became a member of two test methods subcommittees on geotextiles and geomembranes for the Canadian General Standards Board.



Plastics research and testing, for government and industry, has increased. An example of this work is the liner for irrigation canals in southern Alberta.

Working under contract, the Alberta Research Council has conducted research and provided technical assistance to industry in the area of mineral processing. Working closely with provincial and federal government departments, assistance has been provided to clients who are interested in establishing a processing plant in Alberta. Research has been carried out on iron ore, recovery of vanadium from oil sands generated fly ash, beryllium mineral flotation, and fine-grained tantalum columbium mineral beneficiation by oil phase separation. Under the guidance of a renowned consulting metallurgist, research was conducted on the tantalum columbium mineral beneficiation process with the objective of testing the process in a small-scale pilot plant. The Research Council is performing this work for an Alberta company using ore from the Northwest Territories.

Researchers investigated the possibilities of recovering rare earth elements from the ore and of refining beryllium concentrate and tantalum columbium concentrate, and purifying rare earths.

Researchers also have evaluated a magnesium chloride manufacturing process.

Forest products

The Alberta Research Council, supported by Alberta Energy and Natural Resources and Alberta Economic Development, conducts research, development and testing of forest products. It also responds directly to requests from industry for technical assistance. The aims of this program are to provide testing services for industry, to improve processing methods for wood, to develop new products from Alberta aspen wood, and to provide technical data for more effective use of Alberta forest products.

To support the building construction and panel manufacturing industries, the Alberta Research Council acquired computerized equipment for testing full-sized structural panels. The post flexure test equipment enables pure bending to the fracture point, according to industry standards. It also permits automatic calculation of stiffness and breaking strength. These data from tests on full-sized panels give engineers, architects and builders better performance information than the quality control data from tests ordinarily conducted on three-inch-wide panel strips.

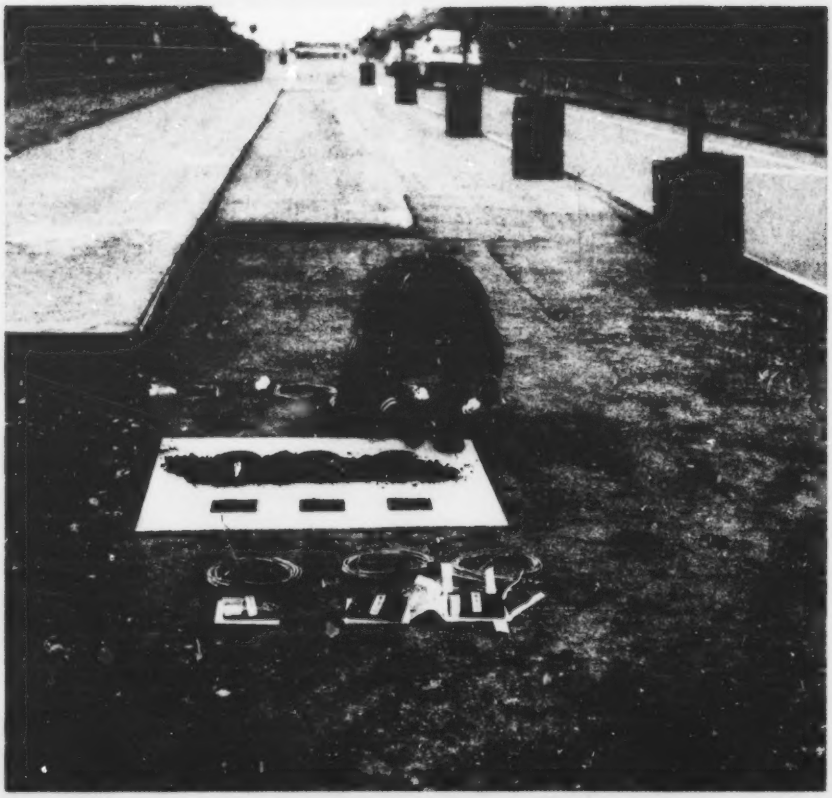
In order to test the effect of concentrated loading and impact loading on panel products, a

floor/roof testing system was constructed. This equipment provides valuable test data for a new panel manufacturer seeking Canada Mortgage and Housing Corporation acceptance of its panel sheathing as a suitable construction material.

In cooperation with the University of Alberta, creep loading (sustained loading) tests of laminated products began. These tests have been followed with interest by the American Plywood Association and the United States Forest Products Laboratory. Forty creep jigs for testing of structural panels were developed. This testing is vital before engineering design values can be assigned to new panel products.

The Alberta Research Council conducted many tests for the oriented strand board and waferboard manufacturers of Alberta in support of code submissions or in support of product or process improvement.

Research engineers assisted with a study on epoxy-steel reinforcement of old beams in historic buildings renovated by Alberta Culture. They also assisted a glulam manufacturer on non-destructive testing of laminated stock. A client company received technical assistance with conducting sustained load tests of 100 days, complying with Central Mortgage and Housing acceptance procedures, for a new type of floor joist required by the building authorities.



Instrumentation for measuring pavement response is installed in New Brunswick at one of 13 test sites across Canada. It is some of the technology the Alberta Research Council is contributing to a national study.

Systems engineering

The Systems Engineering subprogram includes research in transportation, geotechnical and structural engineering.

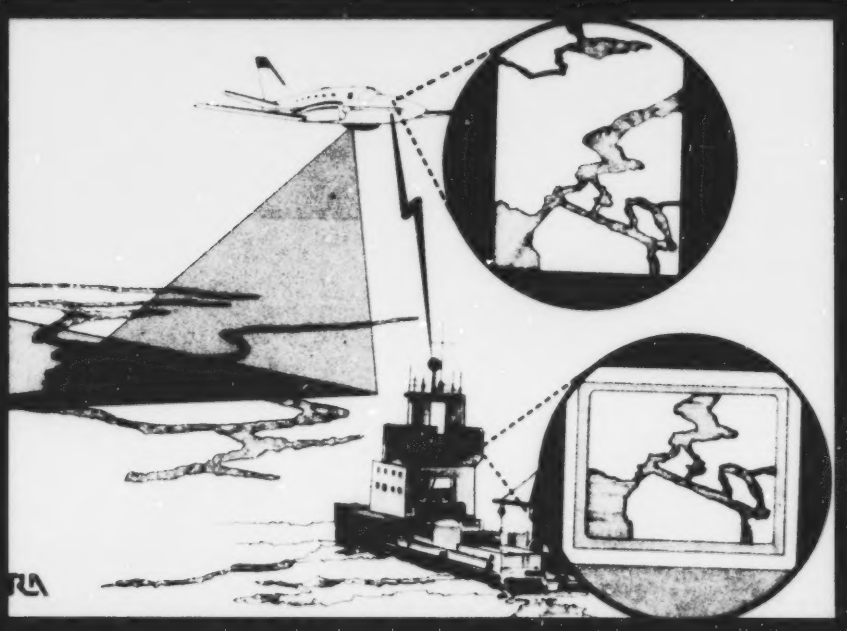
Canroad Transportation Research Corporation has contracted the Alberta Research Council to participate in a national study on the effects of heavy vehicles on pavements making up the interprovincial highway system. Sponsored by the federal and provincial governments and the trucking industry, the objective of this two-year study is to achieve consensus among regulatory agencies regarding the relative, potential damaging effect of various truck axle loads and wheel configurations on pavements. Technology developed at the Alberta Research Council will contribute to the project. That technology includes pavement-embedded instrumentation for measuring pavement response to vehicle loadings, a mobile data acquisition system and software for monitoring the responses, and the application of proven field testing procedures and analysis methods. Research engineers have installed instruments at thirteen test sites across Canada. The Alberta Research Council will direct the field testing program in the spring and summer of 1985.

In recognition of its advanced activities in transportation research, the Alberta Research Council was selected by Roads and Transportation of Canada to represent Canada at an international study of pavement instrumentation. Countries participating in this project demonstrated their instrumentation and pavement response monitoring systems under full-scale field test conditions at Nardo, Italy.

A further opportunity for the transfer of technology lies in the area of traffic data acquisition and analysis. The Alberta Research Council had developed a computer package for monitoring data on vehicle speed, spacing and classification for as many as eight lanes of traffic. The mobile data acquisition system performed successfully in a pilot study for a major national highway research project. This system provides a combination of site location flexibility, ease of installation on site, and accurate, complete traffic data collection, previously unavailable.

Ongoing research supported by Alberta Transportation included quantifying the effects of factors such as traffic, and structural and climatic factors on pavement performance for improving pavement service life prediction models. These models are part of the pavement management system developed for the province. Researchers also have developed the instruments and collected field data to confirm design parameters for geogrid reinforced earth walls. Results of analyses of ice force measurements on bridge piers have provided guidelines for revisions to the bridge code.

Advanced Technologies



A computing system being developed under a joint research project will allow a Calgary consulting firm to produce an image of sea ice in real time and within four to eight hours project its movement. This service can be of great value to offshore drilling operations in the north.

Introduction

The Alberta Research Council started a new research program, Advanced Technologies. Operating from the Research Council's facilities in Calgary, the program has been developed after extensive consultation with industry and universities.

This new program comprises computing and automation technologies which are key to industrial development not only in new high technology industries, but also for product innovation and renewal in existing industries. It aims to assist Alberta firms with research and development to improve their productivity, profitability and competitive position in the national and international marketplace. The program will include projects to expose private companies to advanced technology devices, aids and tools. The program also intends to provide specialized facilities and expertise to firms interested in integrating microelectronic and computer-based systems or in developing software.

Information technologies promoted under the program relate to data collection, processing, distribution and presentation, such as database management, knowledge processing and computer graphics. Automation technologies, another important component of the program, provide for efficient and effective design, development, assembly, inspection and testing of materials and products. computer aided design and computer aided manufacturing (CAD/CAM), information and materials flow, process and adaptive control and robotics are some aspects of automation technologies.

A joint research project concerns the development of a computerized navigational system to process satellite signals which will enable an aerial survey firm to switch from its current use of helicopters to less expensive fixed-wing aircraft.

Review of 1984

Joint research projects with two Calgary-based firms are examples of developments in the information technologies. The joint research project with Nortech Surveys (Canada) Ltd. aims to enhance the company's competitive position by developing a system to allow the precise navigation of fixed-wing aircraft. The technology is based upon the use of global positioning satellites and should provide sufficient precision for aerial surveys. All major components of the system were assembled in 1984. Installation, testing and development of navigation software began during the year.

Joint research with Intera Technologies Ltd. is developing a system to process, distribute and display data from a Synthetic Aperture Radar (SAR) on board an aircraft. The project researchers completed feasibility analyses, using actual data, and obtained computer equipment for the system, named MIDAS (Multi-task Image Data Analysis System). The system is expected to provide major advantages to navigation through ice floes in northern waters, and in the use of SAR for assessment of geological formations.

Alternate energies are also part of the new Advanced Technologies research program. In the Solar and Wind Energy monitoring project, sponsored by Alberta Energy and Natural Resources, seven stations are in operation throughout the province. They measure solar radiation and other meteorological parameters. The project continued collecting and analyzing data towards a scheduled completion in mid-1985.

Small wind-energy conversion systems, using windmills, continued to be studied in a combined demonstration and performance evaluation project for Alberta Agriculture in Lethbridge. The test has included wind-activated water pumping systems, available commercially, which are suitable for irrigation and general farm purposes.

Under contract for TransAlta Utilities Corporation, an investigation of the wind energy regime at selected hydro power sites began in 1984. The project's objective is to evaluate the wind energy budget for pumped water storage applications or for direct energy injection into the electrical transmission system. A one-year monitoring period has commenced at a selected test site.

Applied Sciences

Introduction

Applied Sciences research includes new fields considered to offer long term economic opportunity for Alberta. They are among the fastest growing areas of scientific research, and include hydrocarbon upgrading research, biotechnology and applied computing science.

Review of 1984

Hydrocarbon upgrading

Hydrocarbon research concentrates on investigating novel processes for conversion of bitumen, heavy oils, coal liquids and natural gas into useful feedstocks and transportation fuels. Research in this area supplements and supports coal and oil sands research.

The Alberta Research Council previously demonstrated that soluble metal complexes, containing two or more metal centres, frequently have new or improved features for catalysts compared with complexes containing a single metal centre. Work continued in development of this concept and these materials.

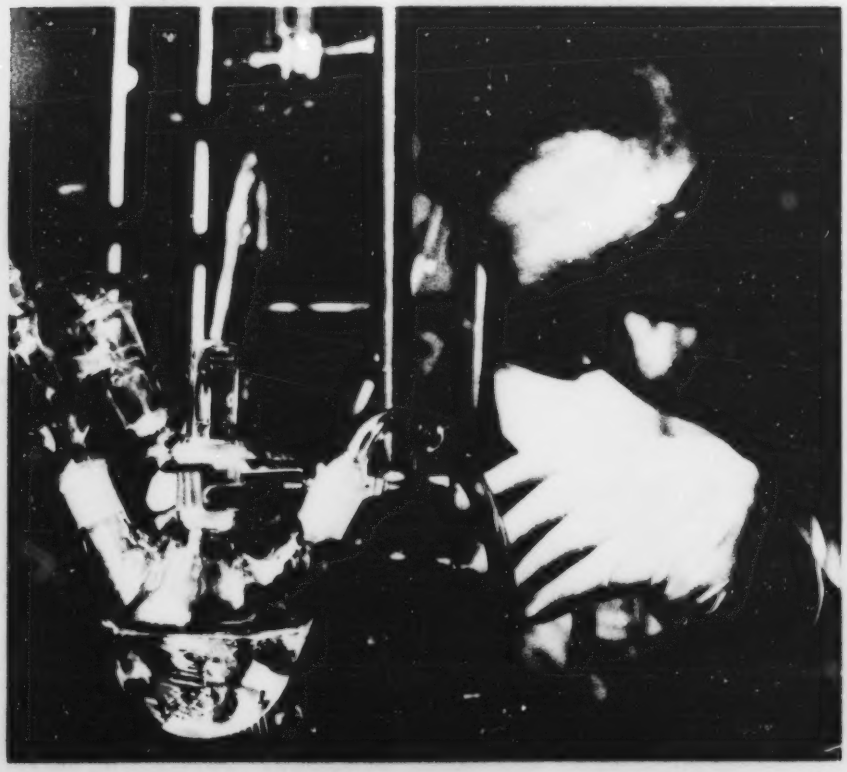
Certain complexes ("A-Frame") contain two metal centres in close proximity, which researchers have shown to be active when treating alkenes such as ethylene and propylene, or alkynes including acetylenes, with hydrogen under very mild conditions only. Researchers investigated the behavior of these complexes under more rigorous conditions than before and in the presence of other potential feedstocks such as carbon monoxide or water. They also observed the behavior of these complexes when treated with carbon monoxide to produce aldehydes, ethers, esters and ketones. This research started to explore how to maximize yields of these value-added products.

To date, only complexes containing two similar centres, or containing one active and one inactive centre, have proven sufficiently stable to be isolated and tested. The Alberta Research Council prepared novel materials which contain two metal centres bridged by ligands at different coordination sites. A future outgrowth of this accomplishment could be the development of metal complexes with two different centres of different, complementary catalytic features which could lead to more effective catalytic reactions or catalytic reactions which can accomplish new tasks.

Other research work on the manufacture of liquid products, of value as fuels or petrochemical feedstocks, included greatly increasing the efficiency of heterogeneous (solid) catalysts which would be a major cost saving for the petrochemicals industry. Traditional heterogeneous catalysts tend to form clusters of 50 to 1000 atoms. Feedstock gas can react with the atoms on the outer portions of the clusters but not with those in the centre of the clusters. Researchers have been working on a process to allow these metal atoms to remain in small clusters of three to six atoms, permitting more effective exposure to the gas and greater process efficiency.

Sour natural gas processing involves separation of the toxic hydrogen sulfide and other contaminants from sour natural gas. It also involves the conversion of hydrogen sulfide to the non-toxic elements of sulfur and water by Claus reaction. Activated alumina is the major commercial Claus catalyst because of its high activity and durability. These catalysts lose their activity with use, however, and have to be replaced by fresh catalyst, at an annual cost to the industry in Alberta of about $5 million. In past projects, the Alberta Research Council has developed a patented process for regenerating Claus catalyst to nearly full capacity. This process could save industry at least $2 million a year and already has the support of some companies. About 18 tonnes of the poisoned catalyst were regenerated by Catalyst Recovery Canada Ltd., (CRCL), in Medicine Hat, and this regenerated Claus catalyst was in commercial operation in 1984 at the Canterra Claus plant at Rainbow Lake. The activity of the regenerated catalyst was proven to be as good as that of the fresh alumina.

Although coking of heavy sour crudes and oil sands bitumen is a commercially proven technology, it suffers from relatively low yield of liquid hydrocarbons and produces large volumes of coke with high sulfur content. The coke's use as a boiler fuel is limited, despite its good calorific value, because of the high



One research project in hydrocarbon upgrading was aimed at greatly increasing the efficiency of heterogeneous (solid) catalysts to produce a major cost saving for the petrochemicals industry.

sulfur dioxide emission. In an attempt to produce an oil sands coke that may be burned with significantly reduced sulfur dioxide emissions, researchers have mixed oil sands bitumen with calcium hydroxide and coked it in the laboratory at 480°C. The resulting coke when burned at 1000°C emitted sulfur dioxide equivalent to 1 percent sulfur in the coke compared with 6 percent in the absence of calcium hydroxide. Other encouraging observations, such as increased coker distillate recovery and decreased off gas production, are being investigated systematically in this joint project of the Alberta Research Council and the Alberta Oil Sands Technology and Research Authority (AOSTRA).

The Alberta Research Council started a joint project with AOSTRA on the upgrading of bitumen to synthetic crude oil and the development of catalysts for upgrading.

Primary upgrading of bitumen can be carried out either by coking processes, such as in the existing commercial oil sands plants, or by catalytic hydro-processing. Higher liquid yields and better product qualities make the catalytic route potentially very attractive. Unfortunately, the metals and ash contents of the bitumen cause a rapid poisoning of the catalyst, which then needs replacement.

In the catalyst development project, researchers initiated a study on two options: the development of high performance catalyst with increased resistance to poisoning, and the development of low cost, once-through catalysts.

In another project with AOSTRA, researchers are investigating the addition of coal to improve conversion of bitumen and heavy oil to synthetic crude. Researchers will be comparing the results of these experiments to determine what proportion of coal and bitumen in this process will lead to the highest conversions to marketable liquid products.

The Alberta Research Council/BIO LOGICALS inc. joint research project increased the capability of its cloning laboratory to become also an "expression" (protein production) laboratory.

Biotechnology

Biotechnology research at the Alberta Research Council undertakes work in three broad areas: a) microbiology, fermentation technology and scale-up; b) plant cell culture and crop improvement for coldhardiness; c) genetic engineering. These areas are represented by both in-house research for the development of new or improved technologies, and contract research for the development of specific products, plant varieties or processes. The Alberta Research Council provided assistance to the province's biotechnology industry through consultation and laboratory studies.

The biotechnology laboratories started moving in 1984 to the Alberta Research Council's new building in south Edmonton, located next to the Edmonton Research and Development Park. By mid-1985, when the move is scheduled for completion, the biotechnology laboratories will occupy an area of approximately 700 square metres, with a fermentation pilot plant of approximately 800 square metres and an indoor plant growth facility of approximately 200 square metres.

The Alberta Research Council developed computerized control technology for fermentation systems. The primary objective has been to improve the scale-up of biotechnology processes by developing methods to measure and control physiological parameters. As a result of that work, the Alberta Research Council announced the first project scheduled for the fermentation pilot plant. The project is a contract with BIO-FROST Inc., of Hamilton, Ontario, a Canadian subsidiary of Advanced Genetic Sciences Inc., (AGS), of Berkeley, California, to develop a commercial production process for an ice-inducing bacteria used in snowmaking. A spinoff from AGS's research program to develop frost protection products, the ice-inducer is made using a scientifically selected strain from natural bacteria found on the leaves and stems of most plants growing in areas of frequent frosts. The bacteria are effective catalysts of ice crystal formation.

Two important crops in Alberta, wheat and alfalfa, require improvements in coldhardiness and frost tolerance. A multi-faceted approach, using tissue culture techniques, will develop new cold tolerant breeding stock for these important crops. Techniques were

The METEOR expert system project, in applied computing science, began in support of atmospheric sciences research with the goal of enabling the system to make the same kind of conceptual "leaps" an expert does when forecasting weather.

being developed for the large-scale production of alfalfa embryos, to be used for artificial alfalfa seeds of clonal uniformity. A corresponding *Rhizobium* project was developing cold-tolerant *Rhizobium* inoculants appropriate to the alfalfa strains developed by this program. Wheat is being improved by the double haploidy technique for increased cold tolerance and frost resistance.

Genetic engineering is conducted in a joint research project between Alberta Research Council and a Canadian biotechnology company, BIO LOGICALS inc. During the year, the project added to its capability as a cloning laboratory by becoming also an "expression" (protein production) laboratory. Researchers constructed two expression vectors, one which works in *E. coli* and the other which works in *E. coli* and yeast. They also were able to clone part of a gene towards making a useful protein product.

Applied computing science

In the last decade, advances in the area of artificial intelligence have created a new area of research and development known as "expert" or "knowledge-based" systems. These systems are designed to represent and operate upon knowledge in particular domains to solve complex real-world problems which otherwise would require considerable human expertise, training and experience. Systems that solve problems in domains as diverse as molecular structure identification using mass spectrometer data, medical diagnosis, and oil and mineral exploration have performed as well as the human experts who worked with computing scientists to design them.

The power of this technology lies in its potential to duplicate human expertise, a commodity that can be expensive, unavailable, or take years to acquire. Its aim is to produce intelligent systems serving as consultants and assistants in a complementary role with human experts where they exist, and providing knowledge and advice where human experts are unavailable.

The METEOR expert system project began in support of Alberta Research Council's atmospheric sciences research. Researchers developed and implemented a representation for changes in space and time. They also designed representation for a causal model of storm prediction and how it interacts with empirical associations. Both the causal and empirical models interact with each other and rely on the spatial and temporal knowledge base already implemented. The system is expected to have the ability to make the same kinds of conceptual "leaps" an expert does when forecasting. However, it also will be able to justify or explain those leaps on the basis of its causal model and temporal/spatial knowledge.

The Alberta Research Council designed the user-system interface for the FLOW system, developed for the River Flow Forecasting Centre of Alberta Environment. The project's goal was to create a simple, non-command based interface for an interactive graphical display system. The final design of the interface simulated "pop-up" menus commonly found on more sophisticated workstations, keeping the user aware of only the relevant decisions to be made at any particular time. Once the user assembles these decisions into a "command," the system can interpret it. The interface also included information for the user about the state of the system, since not all requests could be answered immediately and some requests blocked others.

The long-term Optical Link Experiment, a collaboration between Alberta Government Telephones (AGT) and the Alberta Research Council, has been investigating the operation of an unguided optical communications link by laser beam for data transmission. The distance of transmission was 10 kilometres between the AGT tower in downtown Edmonton and the Alberta Research Council's building in east Edmonton. Initially this optical link operated as part of the Alberta Research Council's computer network. This year, however, the link was decoupled from our network and ran independently. This configuration allowed collection of more detailed information about the performance of the system. Researchers analyzed the large quantity of data generated in the trial, mainly to characterize the correlations between link performance and weather conditions.

Special projects

The Alberta Research Council installed a Nuclear Magnetic Resonance spectrometer capable of handling solid samples. With this apparatus, researchers have been able to measure carbon-13 spectra of a variety of samples, including wood, lignin, coal, peat, asphaltene, forage and protein. The research in 1984 concentrated on the study of lignins from both healthy and decayed aspen wood. In particular, residual lignins from steam-exploded aspen samples after various extractions have been characterized using this technique.

Oil Sands Research

The Alberta Research Council began research on oil sands recovery processes in the Cold Lake Region – the first time outside the Athabasca region.

Introduction

The Alberta oil sands deposits are among the largest hydrocarbon deposits in the world and will play a major role in Canada's future energy production. Two commercial enterprises, Suncor Inc. and Syncrude Canada Ltd., are using very large scale mining technology and a bitumen extraction process pioneered at the Alberta Research Council. From oil sands mined near the surface, they extract viscous bitumen for refining into fuel.

Although the technology for these surface mining techniques is now well developed, surface deposits comprise only 10 percent of the estimated oil sands reserves. The Alberta Research Council's program, therefore, is focused on developing a new technology so that bitumen can be recovered directly from the 90 percent of the oil sand reserves lying 50 to 800 metres underground.

The basic problem is to develop technology for separating the bitumen from the sand deep underground and moving it to the surface. At low underground temperatures the bitumen is so viscous that it acts more like a solid than a liquid. Conventional oil flows easily as a liquid under natural reservoir pressure and temperature. Bitumen must be heated, or mixed with solvents to reduce its viscosity, to allow it to flow through the porous spaces between the sand grains. Usually hot fluids such as steam are injected into the deposit to provide both the necessary heat and pressure to drive the bitumen to production wells. This injection can cause a reaction with the reservoir rock to hinder or assist bitumen recovery. Finally, the successful development of an in situ recovery process requires a detailed understanding of the deposits' geological features.

Review of 1984

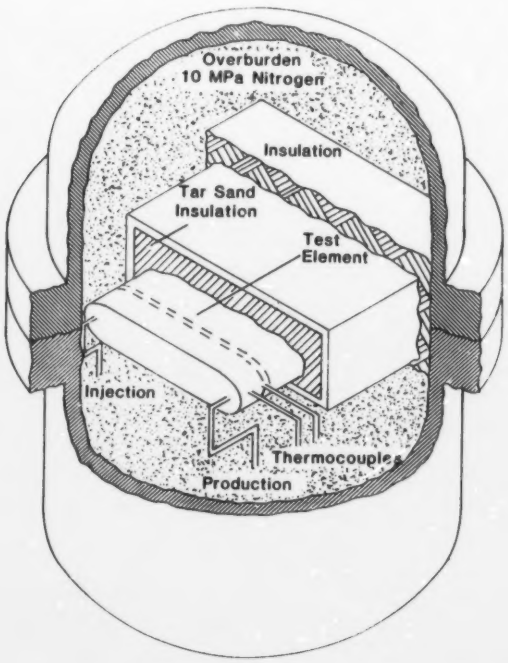
The Alberta Research Council devoted a substantial effort to oil sands research in the Cold Lake region. It was the first time the Research Council had conducted research on oil sands recovery processes other than in the Athabasca region. Given the new developments in the Cold Lake region, this research is timely. In the short term, this work in the Cold Lake area has focused on specific features not found in the Athabasca region and has addressed how technology developed for Athabasca could apply to the Cold Lake oil sands conditions.

Features that are specific to the Cold Lake reservoirs have resulted in new approaches for simulating them in the laboratory. The prevalence of vertical fractures in Cold Lake deposits required development of a new two-dimensional physical simulator which allowed researchers to study a segment of the reservoir adjacent to a vertical fracture plane. Further, unlike Athabasca, Cold Lake does not possess oil sands outcrops, and the reservoir depth makes it impractical to acquire adequate amounts of reservoir material for the two-dimensional test bed. Researchers had to develop techniques to simulate Cold Lake oil sands for their experiments.

Researchers have studied promising recovery processes under Cold Lake reservoir conditions using steam and steam plus carbon dioxide. They have observed that carbon dioxide as a steam additive did not yield the same dramatic improvement in recovery when dissolved gases, such as methane, were present in the Cold Lake bitumen. Since Cold Lake reservoirs tend to have more dissolved gases than those in the Athabasca region, gas additive processes may have more limited application in Cold Lake deposits.

In conjunction with this work research was performed on the chemical interaction between injected hot fluids and the Cold Lake oil sands matrix material. Researchers observed that when carbonate minerals are present in the formation, as they are in the Cold Lake oil sands, the injected steam results in the production of carbon dioxide from mineral reactions. Carbon dioxide, which is sometimes introduced in recovery processes for other oil sands regions, is produced, therefore, as a natural reaction to steam injection.

Numerical modelling also contributed in a major way to research on Cold Lake oil sands. Data from recovery experiments using steam alone and steam plus carbon dioxide, enabled researchers to use numerical models to duplicate features of these recovery processes. A new feature of this work was modelling the effect of dissolved methane gas in the Cold Lake oil



The prevalence of vertical fractures in Cold Lake oil sands deposits required development of a new two-dimensional physical simulator, allowing study of the reservoir adjacent to a vertical fracture plane.

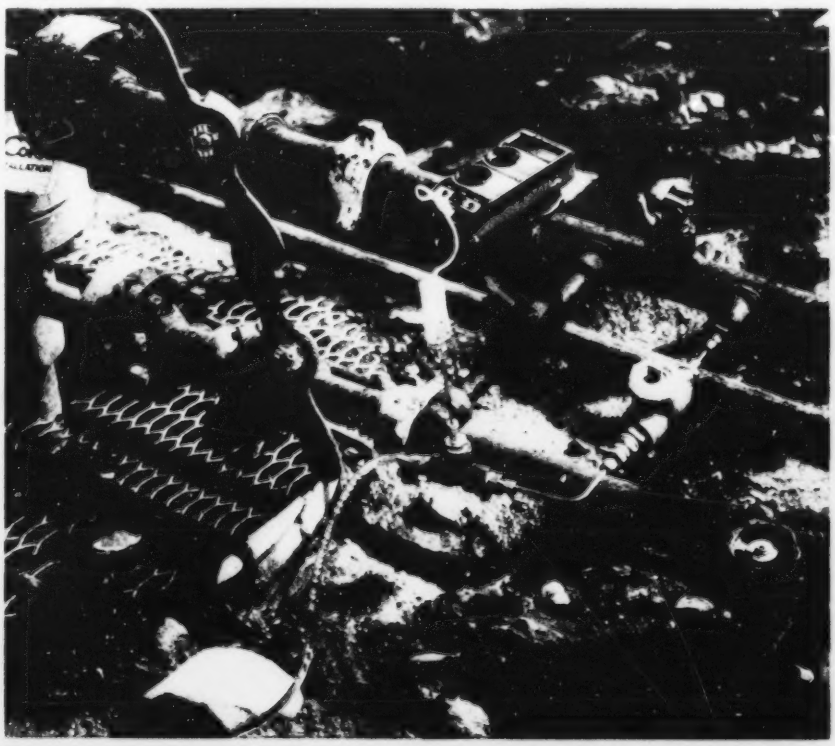
sands, which had not been encountered during previous numerical studies with the Athabasca oil sands.

Another important area of research on the Cold Lake oil sands was in field sampling. The basic goal of this research is to develop techniques for collecting water samples from pilot projects to compare what is injected with what is recovered. This comparison can help monitor changes of minerals in the formation. Researchers developed wellhead sampling techniques. Using data from these techniques, they can predict the reactions to recovery processes used in the respective regions. Pilot plant operators can adjust recovery processes to counter undesirable mineral reactions depending on these data. In the field sampling area, models are now being developed to interpret data.

The relative amount of oil and water in an oil sands formation was studied in order to understand better the flow of fluids through the formation during a given recovery process experiment. Through improved developments using past technology, researchers are now applying the technology of Computerized Axial Tomography (CAT) scanning, based on x-rays, the same technique as is used in medical institutions. This technology allows researchers to observe the flow of oil and water in a three-dimensional way and how water has concentrated or dispersed in the oil.

Another development in 1984 was the addition of a silica transport model to the thermal reservoir model. The effect of silica (quartz) after it has been dissolved with hot water during steam injection and as it is transported through the bitumen recovery flow path can now be projected. Silica, which dissolves at high temperatures near the injection well, tends to precipitate as it is transported closer to the recovery well where the temperature is lower. The result is that the effectiveness of injection solutions decreases with distance from the well because of this buildup of silica. With dissolution and precipitation rates established for various processes and recovery conditions, the computerized silica transport model enables researchers to predict how much dissolution there will be, how fast it will occur

Numerical modelling was completed on how the relatively high amount of dissolved methane gas in the Cold Lake oil sands affects recovery processes designed for the Athabasca region.



Researchers developed techniques for wellhead sampling at in situ oil sands projects. This sampling helps predict the reactions to recovery processes used in different regions.

over distance and where the silica will precipitate.

For the first time, the capillary pressure between fluid phases in oil sands at elevated temperatures was measured. This knowledge contributes to better understanding of how capillary forces assist the movement of bitumen through the oil sands formation to the recovery well. Now that this capillary pressure can be measured, researchers can improve projections of their laboratory results to the field.

Also for the first time, a series of experiments was completed with pure sand to measure the relative permeability of the bitumen-water system at field conditions (125°C to 250°C). Until these experiments were completed in 1984, researchers were unable to create reproducible conditions suitable for the study of oil sands. This understanding helps measure the total amount of oil which can be recovered and the rate at which it can be recovered. Work will continue by checking experimental results with the pure sand against field samples of oil sands.

To determine the volume and rate of recovery of bitumen, it is important to know the bitumen viscosity at reservoir conditions. Using a viscometer built in 1983, researchers have been able to measure a range of viscosities of bitumen from a given oil sands region in a relatively short time (in the 50°C to 250°C range and at pressures up to 2000 psi).

To overcome the problem of sand plugging production wells, when sand is transported in production fluids in the cyclical steamflood process of bitumen recovery, the Alberta Research Council developed a sand exclusion filter under contract for Texaco Canada Resources Limited. Existing sand control techniques had not proven satisfactory in the harsh environment typical of thermal recovery in oil sands. Expertise previously developed at the Alberta Research Council contributed to the development of the "sandwich filter" which has now been patented. The filter is undergoing field testing.

A patent was issued on a sand exclusion filter, developed under contract for Texaco Canada Resources Ltd. The filter helps overcome the problem of sand plugging production wells in the cyclical steamflood recovery process.

Regional geological investigations on all of Alberta's major oil sands and heavy oil deposits continued. These investigations involved facies analysis, petrographic analysis and subsurface mapping. Facies and depositional environment reconstructions neared completion for several of the Lower Cretaceous Mannville Group deposits. For the Gething Formation, in the Peace River deposit, an estuarine-tidal origin is interpreted. In the Athabasca deposit, the McMurray Formation shows a fluvial setting, with large meandering channel trends in which the best oil sand reservoirs are found. In the Wabasca deposit, the Grand Rapids Formation reflects a wave dominated, nearshore and shoreline setting. In the Cold Lake-Lloydminster areas, fluvially dominated shoreline and nearshore depositional environments are interpreted. These reconstructions provide valuable predictive insight into reservoir geometry.

Researchers completed petrographic and diagenetic studies for the Peace River oil sands and the glauconitic reservoirs at Suffield. Regional subsurface mapping was completed for the northern portion of the Athabasca deposit and is well advanced for the Peace River and Wabasca deposits. Mapping of the southern part of the Athabasca deposit was begun.

A detailed reservoir study was started for the underground test facility being developed by the Alberta Oil Sands Technology and Research Authority (AOSTRA). Also, through AOSTRA/industry technical advisory committees, researchers continued to provide geological input to the operations of specific field pilot plants. Internationally, a study of the Peruvian La Brea de Chumpi oil sands was completed for AOSTRA and the government petroleum agency in Peru.

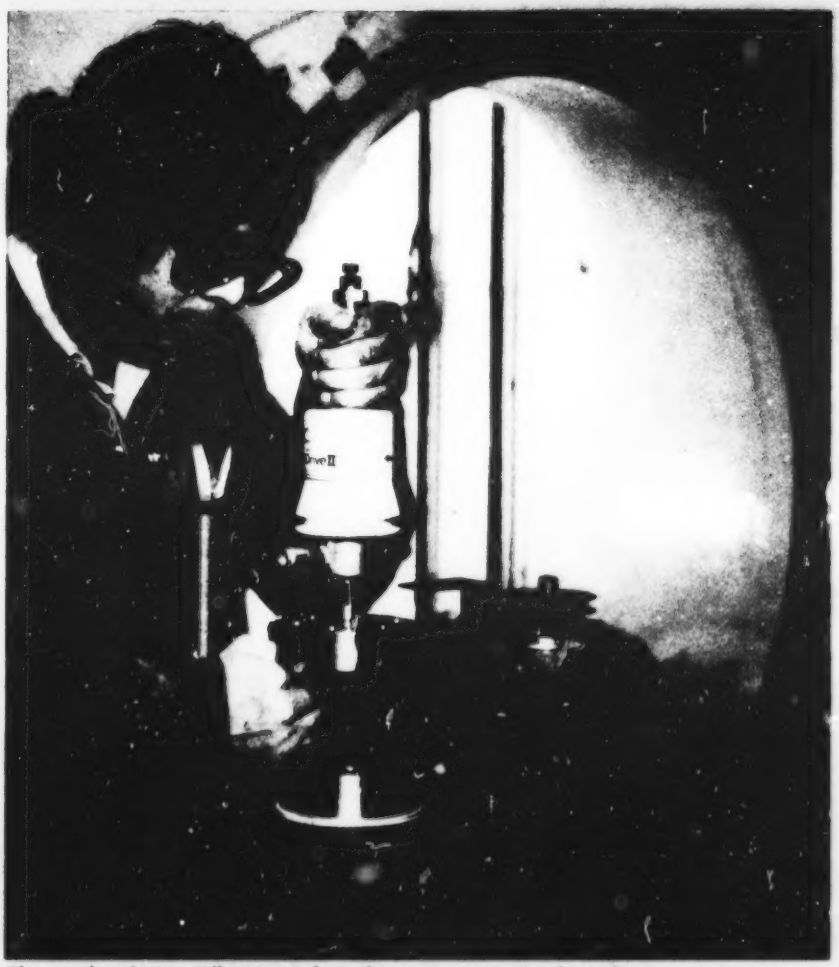
Coal Research

The Alberta Research Council now has the full range of experimental units to represent the major processes for a typical coal mine. Research results will provide data on the complete upgrading of a typical subbituminous coal and its conversion to products.

Introduction

Alberta has most of Canada's known coal reserves, which amount to at least as much energy content as all known reserves of oil sands and heavy oil in the province. The extent, quality and availability of coal reserves underneath the Alberta plains makes coal a major potential source of liquid fuel to meet the energy demands of future years. Coal can be converted to many products such as fuel gas and synthesis gas for hydrogen and ammonia production, but liquid fuels remain the most attractive because they can be transported cheaply over long distances. The high energy density of liquid fuels also makes them uniquely suitable as fuels for transportation and agriculture. Furthermore, Canada's desire to become self-sufficient in energy, and efficient coal conversion technology of the kind the Alberta Research Council is investigating, could make coal economically competitive as a future source of synthetic fluids.

Considerable information about European, eastern American, Japanese and Australian coals is already available. Western Canadian coals, however, are different in physical and chemical structure and geological origin. Since coal conversion processes depend on the characteristics of the feed coals, the Alberta Research Council is investigating coal conversion technologies suited to local coal characteristics and production capabilities. It also is investigating the geological characteristics of the coal deposits themselves. This research is funded jointly by the Alberta Research Council and the Alberta/Canada Energy Resources Research Fund.



The study of nine Alberta coals in five representative liquefaction processes was completed under the autoclave project.

Review of 1984

Based on previous work, new research was conducted on coal agglomeration. Previous agglomeration research has demonstrated how small amounts of heavy oil added to coal-water slurries results in agglomerates (balls of coal up to the size of marbles) when pumped through a pipeline. It also demonstrated the simultaneous beneficiation of different grades of Alberta coals by removing ash. Ash, which is detrimental to the coal conversion process, remains with the water in the slurry; the high quality agglomerates of coal are attracted to the oil in the slurry. This process could make Alberta coal more competitive on the world market for thermal coals and, for future economy, should make the conversion of coal to synthetic oil less expensive.

Research was conducted on agglomeration in stirred tanks instead of pipelines, for an Alberta company. In collaboration with the Electric Power Research Institute of the United States, the Alberta Research Council started investigating beneficiating coals from different regions in the United States.

Phase I of the pyrolysis program, which was the evaluation of pyrolysis properties for thermal coal regions in Alberta, was completed. The laboratory evaluation included tests on ten coal samples from seven coal fields. The report on Phase I, which marked a major milestone in the pyrolysis project, identified optimum conditions for maximum oil yields and concluded there were no significant differences among test coals from the different coal fields.

Flash hydropyrolysis tests conducted in the presence of hydrogen gas successfully identified the operating conditions for producing high yields of benzene. Benzene is a valuable chemical used mainly as an additive to gasoline and for the production of plastics. The flash pyrolysis process, generating benzene as a byproduct from coal used for power generation, will require research to identify the best operating conditions, after which the economic viability can be determined.

In the liquefaction program,

researchers completed the autoclave project which studied nine Alberta coals in five representative liquefaction process types. A report was issued which classified the reactivities of coals from different fields and also identified promising process types for converting Alberta subbituminous coals to liquid products. Coals from the Horseshoe Canyon Formation were found to be more reactive than coals from the Paskapoo Formation.

Based on these scoping studies, detailed evaluations were conducted on the bench unit which was fully commissioned. Using two reference coals, one with high reactivity (Vesta coal), the other with low reactivity (Highvale coal), a dispersed molybdenum catalyst was evaluated on the bench unit in a single-stage reactor mode. By determining process conditions for each coal separately, it was demonstrated that high conversions (70 percent of coal) to liquid products could be obtained. Less severe process conditions were needed for Vesta coal than Highvale coal. To improve the quality of the liquid products the bench unit is being converted to a two-stage reactor mode.

Two-stage coprocessing of low reactivity Highvale coal with bitumen was studied on the hot charge experimental unit using carbon monoxide gas in the first stage and hydrogen gas in the second stage. The results obtained thus far indicate that this approach gives both high conversion of coal to soluble products and simultaneous upgrading of the bitumen charged with the coal into the reactor. Process conditions in each of the two reactor stages are being tested to compare this approach with conventional liquefaction.

Primary coal liquids, such as those produced in the above processes, require further upgrading in order to meet the specifications for transportation fuels. These upgrading processes are also being investigated in the research program.

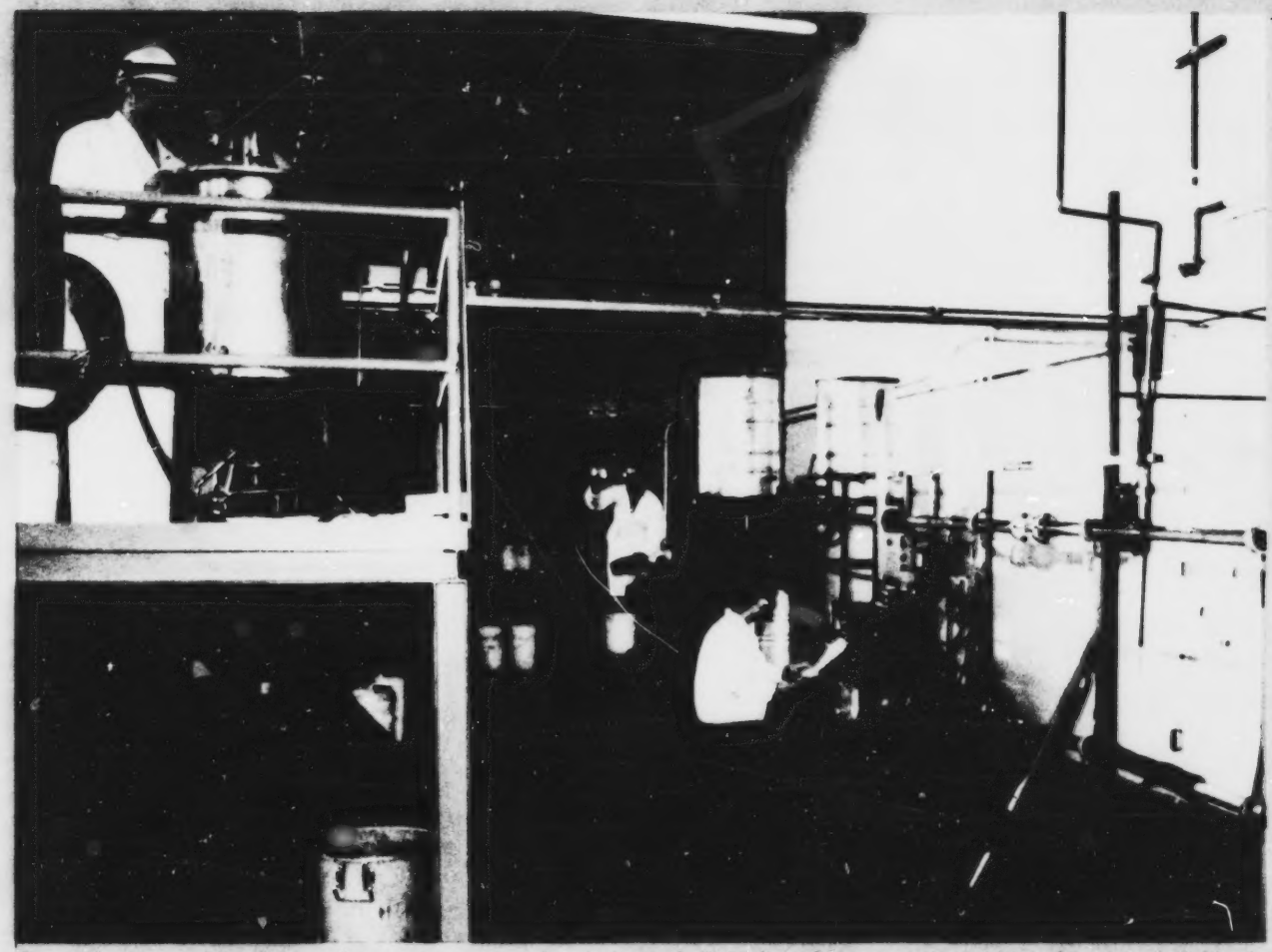
A continuous stirred tank high pressure/high temperature reactor of the Berty type started full operation for the hydrotreating of coal liquids, a process in which the heteroatoms (nitrogen, oxygen and sulfur) are removed. A similar unit, of the Robinson type, was assembled during the year and designed to operate in the hydrocracking mode, thereby increasing the hydrogen to carbon ratio of the heavier coal liquid fractions. A third upgrading unit, namely a catalytic reformer, also started operation, for research on the production of high octane gasoline and petrochemicals from coal liquids. These units represent the major processes that are taking place in a typical refinery, and offer researchers the opportunity to obtain technical data on the complete upgrading of synthetic fuel derived from bitumen and coal to marketable liquid products.

The use of coal petrography to study the contribution of different macerals in the liquefaction process introduced "applied petrography" to the study of coal conversion processes.

Coal petrography, the microscopic study of coal composition, determines macerals content and measures reflectance and fluorescence. Macerals are fundamental ingredients of coal, as are minerals in other types of rock. Reflectance and fluorescence indicate quality by the extent to which conversion from original organic matter to coal has taken place. Since 1980, the Alberta Research Council has developed an internationally recognized, world-class laboratory for coal petrography. A fluorescence spectral analysis for coal macerals was introduced to characterize the hydrogen enriched components in coal.

In addition to introducing this state-of-the-art technology, the Alberta Research Council completed applications of petrography to residue materials following coal liquefaction to understand the contribution of different macerals in the liquefaction process. This investigation introduces "applied petrography" to the study of coal conversion processes.

Coal geology research remained



Research was conducted on agglomeration in stirred tanks instead of pipelines for companies wishing the option of shipping coal already agglomerated and at full value added.

centred on Cretaceous and Tertiary coal formations in the Alberta Plains subsurface. Funded jointly by Alberta Energy and Natural Resources and the Alberta Research Council, this project has two main objectives: to evaluate the coal resources and identify commercial coal seams to depths of 400 metres, and to develop geologic techniques for predicting distribution, thickness, and continuity of coal seams in the plains region. Research has included studies of the coal deposits of the Horseshoe Canyon Formation and the Ardley zone of the Paskapoo Formation. The Horseshoe Canyon coals for the area between the United States border and township 64 were the focus of an extensive team effort.

A variety of computer-derived structural, stratigraphic and seam thickness maps have been produced, and a predictive model has been developed to explain the distribution of the major coal seams. Documentation of variations in coal rank within the Ardley zone has continued.

Studies on the structural geology of the Grande Cache coal field are in the final stages. An understanding of the relationships between folding and thrusting help predict the geometry of economic coal seams within the area. Structural studies in the Highvale Mine area, Wabamun, defined distinct fracture patterns. These fractures, which include joints and shear planes caused by deformation induced by the pressures of glacial ice when the area was glaciated, are a major control on highwall stability within a mine. Studies of this kind should therefore prove very useful in future mine design programs.

Natural Resources

Terrain sciences research at the Alberta Research Council is the study of soils and groundwater resources in the province. It includes projects to support industry such as the reclamation of land for farming and other uses following the surface mining of coal.

Atmosphere

The Alberta Research Council was in the fourth year of a five-year weather modification research project, sponsored by Alberta Agriculture and the Alberta Research Council. The objectives of this project are to assess whether cloud seeding influences hailstorms sufficiently to cause a change in hailfall and to assess the potential for increasing rainfall by seeding cumulus clouds in southern Alberta.

The most encouraging results of cloud seeding experiments yet carried out by the Alberta Research Council are those from single-cloud seeding trials on cumulus clouds to produce rain. The experiments are designed to determine the effects of seeding on precipitation growth processes in cumulus clouds and to determine the most effective seeding technique. Experiments carried out this year continue to verify earlier observations that seeding with dry ice or silver iodide, when conditions are right, can produce changes within the cloud that lead to formation of precipitation-size particles. As of this year, the Alberta Research Council has one of the larger sets of case studies of cumulus seeding experiments of any such project throughout the world. This means that better statistical significance can be assigned to the results.

The hail experiments are more difficult to do since the aim is to carry out different types of seeding treatments on towering cumulus clouds associated with a hailstorm. Observations of a seeded storm are then obtained with the research aircraft, the weather radar system and often with observers in trucks attempting to gather hailstones as they fall to the ground. Analysis of the hailstone data has demonstrated that the size and number of hailstones can be described by a simple mathematical function. Indeed, research has determined that this function can be in part related to the storm thermodynamics. In particular, it has been found that the temperature at the base of the storm cloud can be related to the hailstone size distribution. This suggests that if the cloud-base temperature is known, then the size and number of hailstones can be predicted. Therefore, if sufficient hailstone samples can be obtained from a storm, together with a cloud-base temperature, it may be possible to detect a seeding effect if cloud seeding alters the number and size of the hailstones.

The Alberta Research Council completed a contract for Environment Canada's Atmospheric Environment Service of contributing its weather radar observations to the interpretation of satellite images for a more accurate system of forecasting storms.

Contracts for cloud seeding operations were continued using aircraft to seed hailstorms over a 25 000 square kilometre area in central Alberta and using ground-based generators in a 10 000 square kilometre area in southern Alberta.

The Alberta Research Council is also in the final phase of a three-year study with Alberta Environment to obtain airborne measurements of emissions from oil sands plants, in the Fort McMurray area. Air parcels sampled with the research aircraft at various distances downwind from the stack are analyzed to determine the transport and transformation of pollutants. In the latter phases of the project, an additional objective has been to determine the redistribution of pollutants by clouds. (Pollutants can affect the precipitation processes in clouds and clouds can redistribute the pollutants.) An interesting observation made during a series of flights in cold, stable air was that ice crystals started to grow in the emission plume and grew sufficiently to fall out of the plume to the ground several kilometres downwind from the stack. This snowfall is dependent upon the characteristics of the emissions and may represent a mechanism for removing pollutants from the emission plume.

The Alberta Research Council was again requested to act as a consultant to Raytheon Company, one of two companies competing to define the next generation of weather radars, in its bid to supply the system to the United States government.

Dry conditions in southern Alberta have spurred interest in the possibility of increasing snowfall over the southern Rockies. In this connection, the research aircraft has flown several winter missions in the Pincher Creek region to determine whether orographic clouds over the mountains contain a potential for augmenting the snowfall by cloud seeding. Limited analysis does show that some potential exists. A preliminary analysis of the snow climatology of the Rockies south of Banff has also been completed as part of a background study.

A contract was completed with Environment Canada's Atmospheric Environment Service to support their RAINSAT Project designed to improve short term weather forecasting by analyzing radar and satellite data. As a result of this contract, the Alberta Research Council now has the capability to process GOES (Geostationery Operational Environmental Satellite) data tapes and to produce colored maps of infrared and visible satellite data.

A project, funded by the Canadian Electrical Association and the Alberta Research Council, was initiated to study the forecasting of damaging lightning from radar observations. Preliminary results suggest that lightning frequency is related to maximum reflectivity (a radar measure of storm intensity) and the area of reflectivity equal to and

greater than a specific echo intensity (40dBZ). Work is now underway to find similar correlations for lightning intensity.

Terrain sciences

The Alberta Research Council has traditionally played a major role in land resources inventory. In 1984, research geologists completed Quaternary geology studies of four 1:250 000 map areas and a broad compilation of the province's glacial geology south of the 54th parallel. They also completed geologic stratigraphy studies in the Medicine Hat area and along the Firebag River, north of Fort McMurray. Field mapping was completed for a 1:50 000 scale soil survey of Paintearth County which will be used to help locate and devise ways of improving areas of low productivity solonetzic soils. Researchers also completed soil surveys of Two Hills and Beaver Counties and soil survey and surficial geology reports of the Calgary urban perimeter.

Alberta Research Council geologists also contributed their knowledge from field mapping, particularly related to glacial thrusting, to help predict and minimize costly slope failures in open pit coal mines. This work continued to meet the needs of the coal mining industry. Soils researchers also started a project to help determine the most economical and scientifically valid ways of classifying land for irrigation potential, and of mapping different types of peat deposits.

Bank erosion and its control is a serious and costly problem in parts of Alberta. One goal of research on this problem is to develop methods for predicting the occurrence and rate of erosion and for minimizing the cost of arresting bank erosion. Bank erosion, sediment transport and bed scour were analyzed and measured in numerous gravel and sand bed rivers as part of joint projects with Alberta Environment and Alberta Transportation.

Sediment transported by rivers can affect the design of water supply facilities and the suitability of river sections for fish habitat, and can act as an agent in the transport of contaminants through a river system. Research is being conducted which examines the amount of sediment delivered to a river and the mechanisms by which this material is transported.

Ice can pose significant problems in rivers in northern locations such as Alberta. Ice also has an important role in determining the fall and winter operational practices of dams used for power generation. Researchers, therefore, are investigating freeze-up processes on the North Saskatchewan River at Edmonton and on the Peace River at Peace River in order to provide techniques for predicting the strength of ice accumulations at freeze-up and the effects of ice on flow characteristics. River breakup processes were also being analyzed and methods of predicting spring breakup, and water levels as a a result of ice jams, were being developed.

A joint research project of the Alberta Research Council and the Alberta Forest Service began on the effect of forestry operations on the hydrologic, hydraulic and sediment regimes of watersheds. The research has been examining the effects of different timber harvesting procedures on three small streams in the upper McLeod River basin south of Hinton.

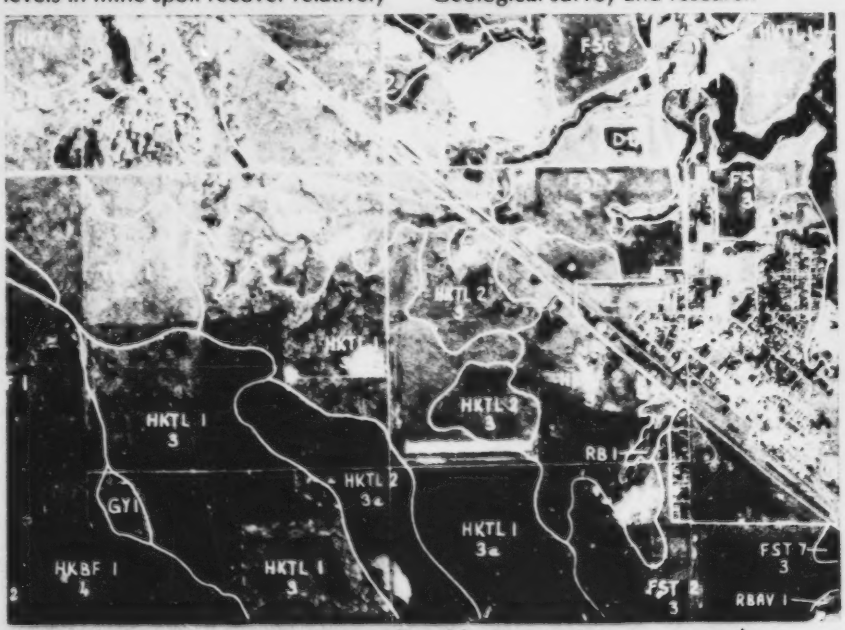
The largest single project in land reclamation is the Plains Hydrology and Reclamation Project which is supported by the Land Conservation and Reclamation Council. The first phase of this study demonstrated that groundwater in mine spoil is generally of degraded quality, that water table levels in mine spoil recover relatively quickly, and that, at least in some settings, the water table can be significantly above pre-mining levels and quite close to the surface. The second phase of this study will emphasize the development of landscape design factors for reclaimed areas that will minimize potential salinization of reclaimed soils by this degraded water.

Alberta Research Council scientists also studied groundwater recharge, flow, and discharge in the Black Spring Ridge area (near Carmangay, Alberta) as it related to the development of saline seeps and saline soils. The flow systems were found to be complex with salinity developing in at least four different hydrogeological settings. The study will be extended to define further the shallow flow system and to delineate the recharge areas for this shallow system.

A soil erosion research project began to define in quantitative terms the amount of soil erosion on various landscapes in east-central Alberta and how it is affected by current land-use practices. Alberta Research Council scientists also conducted studies on the effects of environmental contamination and industrial waste management on the soil and groundwater resources of the province.

Earth resources

Geological survey and research



A typical photomosaic soils map produced by Terrain Sciences researchers.

Aggregate Inventory staff investigate sand and gravel deposits throughout Alberta, such as this pit on the North Saskatchewan River west of Edmonton.

projects at the Alberta Research Council are mainly involved in identifying the nature and extent of Alberta's mineral and energy resources. One highlight of 1984 was the completion and publication of the last of 36 geological maps covering the Precambrian Shield in northeastern Alberta. Also completed were the geophysics and geochemistry study components, which, along with earlier published works, brought this longstanding project to a close. The many products of this project constitute some of the most detailed geological mapping of any segment of the Canadian Precambrian Shield, and will be invaluable in future mineral exploration.

Aggregate mapping continued as one of the Alberta Research Council's important mineral resource studies, under contract for Alberta Energy and Natural Resources. With most of the populated regions of the province now mapped in detail, attention was directed to more remote areas, in a more reconnaissance level of mapping. Another thrust of this project was a supply/demand investigation of aggregate sources in the Edmonton-Cold Lake region. This study related mapping and inventory data to various factors of mineral economics, in support of resource management for the region.

Stratigraphic and petrologic studies of the uranium-bearing, Precambrian Athabasca sandstone were completed for publication. Followup to that work is a study of the underlying regolith and crystalline basement rocks. These projects will contribute substantially to the evaluation of Alberta's uranium potential.

Petroleum geology studies were focused on oil accumulations within the Triassic succession of northwestern Alberta. Evidence from those studies suggests the stratigraphic pinchouts creating the traps are depositional rather than erosional features.

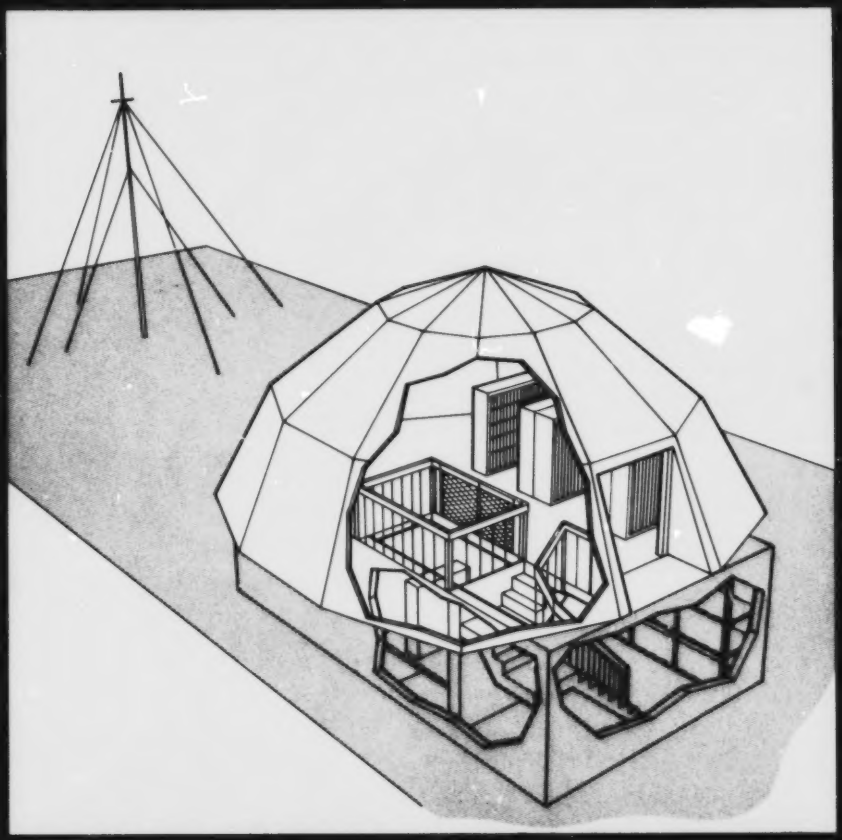
A project of basic subsurface mapping of petroleum reservoir rocks was supported in part by Alberta Energy and Natural Resources. Four subprojects were active in 1984: regional stratigraphy of the Devonian Grosmont Formation; northern extension of Leduc (Rimbey Meadowbrook) reef chain beneath the Grosmont Formation; stratigraphic relations of Jurassic and Cretaceous sand reservoirs in west-central Alberta; correlations within the Devonian "shale basin" between the West Pembina and Meekwap areas. The first three subprojects were completed during the year.

Another project started was the study of Devonian stratigraphy of the Peace River Arch area. This project is part of a large-scale, long-term study of tectonic and depositional history, and hydrodynamics in the region of the Peace River Arch structure.

Research in palynology and ichnology provided fundamental data in support of studies in petroleum, regional subsurface, oil sands and coal. In palynology, two major synthesis studies were underway on coal-bearing Cretaceous strata of the Red Deer River Valley and on the Lower Cretaceous oil sands deposits. In ichnology, major studies of Hibernia and other east coast cores were completed under contract.

Basin analysis is a new research thrust which includes various geoscience disciplines in the mathematical modelling of fluid flow in deep sedimentary basins. Major effort was directed at investigating the baseline hydrogeology of the Cold Lake area. Jointly funded with Alberta Environment, this study is essential for future assessment of the impact of commercial in situ recovery of bitumen from the Cold Lake oil sands deposit. Another study of potential waste injection aquifers beneath oil sands and heavy oil deposits was carried out under contract for Environment Canada.

Electronics Test Centre



A conceptual drawing of an open-field site for electromagnetic interference testing to be part of the $11-million Electronics Test Centre being sponsored by the Alberta Research Council to support the electronics industry in western Canada.

Introduction

A survey of Alberta industry indicated some 20 companies were spending approximately $500 000 annually to have their products certified. With about 100 small- and medium-sized electronics product manufacturers already established in the province, it is estimated the testing business will increase to $1 million annually as Alberta's relatively new electronics industry competes on world markets.

Review of 1984

In response to the survey of Alberta industry, the Government of Alberta selected the Alberta Research Council to develop a $10 million Electronics Test Centre. The plan for the centre was based on a business plan developed jointly by the Alberta Research Council and Bell Northern Research.

The test centre will assist Alberta electronics manufacturers to penetrate and compete in Canadian and world markets. It will occupy 2230 square metres of space in the completed portion of the Alberta Research Council's head office and laboratory complex under construction in south Edmonton. This portion of the test centre will be devoted to product safety testing and integrity evaluation, functional testing for product performance verification, terminal attachment verification, and walk-in chambers for testing environmental and electrical noise susceptibility. Another 9290 square metres of adjacent land is to be designated for an open field test site for electromagnetic interference testing.

The centre is being built with the help of a three-year, $6.2 million capital grant from the Alberta Heritage Savings Trust Fund, combined with an operating budget from the provincial government's general revenues. By the end of the third year of operation, the centre is expected to become a self-supporting business.

The test centre is the first of its kind in western Canada. The centre is expected to receive accreditation from the Standards Council of Canada, the Department of National Defence, the Department of Communications and the Federal Communications Commission. Official recognition by the Canadian Standards Association, the Underwriters' Laboratories Inc. and other national certification organizations in the United Kingdom, West Germany and Japan is also anticipated.

The test centre will serve industry in the four western provinces.

Information and Support Services

Housing contractors building energy efficient homes, such as this one installed with solar panels, can make use of the SWERP Information Centre for information on solar and wind energy and energy conservation. The Centre is part of a network of information centres at the Alberta Research Council.

The Alberta Research Council operates six information centres to provide information for industry, government, the general public and staff. The major research programs also receive support from a variety of other services: technical laboratories, a computing network, machine shops, instrumentation repair, graphics, human resources, safety, financial services, editing and publications sales and public relations.

Alberta Oil Sands Information Centre
Managed by the Alberta Research Council, the Alberta Oil Sands Information Centre is funded by the Alberta Oil Sands Technology and Research Authority (AOSTRA). The centre is a central source of all published information on oil sands, enhanced recovery processes and heavy oils. It responded to approximately 3000 enquiries in these areas.

On-line access to the bibliographic databases is provided by QL Systems and CAN/OLE, based in Ottawa, and SPIRES at the University of Alberta.

The centre also maintains a numerical database on international information about physical properties of oil sands, in conjunction with the Alberta Research Council's Oil Sands Sample Bank. A bi-monthly newsletter, the *TAR Paper*, was distributed to over 1800 subscribers in 31 countries.

Coal Technology Information Centre
The Coal Technology Information Centre is jointly funded by the Alberta Research Council and the Alberta/Canada Energy Resources Research Fund. The centre provides information on mining technology, coal beneficiation, coal conversion (liquefaction and gasification), combustion, environmental aspects and energy policy.

The Coal-Abs database increased by 3500 entries to a total of 17 000. In order to make this information accessible to people working in the area of coal, the centre produces the *Current Acquisitions Bulletin* (Coal-Abs), a semi-monthly update of new material added to the database. Coal-Abs is also available on-line through SPIRES at the University of Alberta. The centre responded to enquiries from researchers, industry, academia and the general public.

Information Geology
Information Geology has undergone continued growth in both the use of its bibliographic geoscience database, GEODIAL, and the handling of geologic enquiries. GEODIAL now contains approximately 6000 records and was used to produce indices for two contributing agencies. The centre produced an index for the Canadian Society of Petroleum Geologists in both book and microfiche forms for all their literature, from 1977 to the end of 1983. The centre also prepared an index for the Geological Association of Canada's journal, *Geoscience Canada*.

Industrial Information
The Industrial Information centre interacts mainly with manufacturers and scientific/engineering companies as part of the Industrial Development Department. Clients in Alberta have access, through offices in Calgary and Edmonton, to 95 percent of the world's published scientific and technical literature in the more than 600 databases of 11 computer systems in Canada, the United States and Europe. This service was provided to people from the Alberta Research Council, the National Research Council, industry and government. Over 1000 enquiries resulted in 3000 bibliographic searches. As a result of these searches, about 2900 documents were processed. Industrial Information also produced *COIN: A Directory of Computerized Information in Canada*, 5th edition, 1984.

SWERP Information Centre
The SWERP (Solar and Wind Energy Research Program) Information Centre is jointly funded by the Alberta/Canada Energy Resources Research Fund and the Alberta Research Council. The centre collects and disseminates information on solar and wind energy and related technologies. This collection comprises the basis of the SWERP database, an on-line subfile publicly available through SPIRES at the University of Alberta. Requests for information came from the general public, governments, industry and commercial sectors, educational institutions and other libraries and information centres. The centre also continued its involvement with the Canada Institute for Scientific and Technical Information (CISTI) in the joint development and provision of ENERCAN, the Canadian renewable energy database. The SWERP Information Centre responded to 1231 enquiries on renewable energy and remains a key focal point for on-line access to information in this subject area.

Library
Library Services provides information service and relevant, technical collections in support of current research through its various locations. This information support system is essential to the Alberta Research Council's effectiveness as a research centre. SCITECH, a public on-line catalog, on SPIRES at the University of Alberta, was created and developed

New methods for the analysis of trace elements in coal and soil extracts by graphite furnace atomic absorption were instituted by the Chemistry Analytical Laboratory.

by the library staff of the Alberta Research Council, Alberta Agriculture and Alberta Environment. The first SCITECH "technology transfer" was executed when a copy of the SCITECH software was authorized for use by Alberta Labour. Besides full on-line access, SCITECH products include a union COM catalog (author/title and subject), individual book catalogs for branches or special collections, shelf lists, accessions lists and subject bibliographies.

Analytical services

The *Chemistry Analytical Laboratory* provided analytical services for projects in all research programs of the Alberta Research Council. The laboratory also provided services to external clients, including the Department of National Defence, Environment Canada, Alberta Provincial Museum, Alberta Occupational Health and Safety, Alberta Provincial Analyst, various University of Alberta departments, and private industry. New methods for the analysis of trace elements in coal and soil extracts by graphite furnace atomic absorption were instituted and a sensitive technique for measuring herbicides by oxygen enhanced negative ion chemical ionization GC/MS (gas chromatography/mass spectrometry) was developed. Analytical instrumentation available in the laboratory include flow injection analysis, atomic absorption, inductively coupled plasma spectroscopy, x-ray fluorescence, nuclear magnetic resonance, infrared spectroscopy, and gas chromatography/mass spectrometry.

The *Coal Analytical Laboratory* provided analyses of coal and coal-derived products in support of the two major coal conversion projects, liquefaction and pyrolysis. The establishment of a computerized system of laboratory data storage and retrieval continued. Hardgrove grindability and low temperature ashing were introduced and trace N-determination established. Flexibility of thin-layer chromatographic class separations using flame-ionization detection has been demonstrated, rendering the method useful for fast "class analysis" of heavy fossil liquids and residual. Gel permeation chromatography has been introduced. The laboratory also participated in round robin tests

With the installation of a CXP-200 nuclear magnetic resonance spectrometer, researchers were able to start analyzing the chemical bonding in common elements in solids instead of just liquids and solubles.

organized by CANMET (Canada Centre for Mineral and Energy Technology) and ASTM (American Society for Testing and Materials) and provided advisory services and specialized analyses to outside clients.

The *Gasoline and Oil Testing Laboratory* provides a wide range of testing and inspection services on refined petroleum products for city, federal and provincial government departments and to the private sector where the analytical capability is not available elsewhere. The laboratory also administers, on a contract basis, three sample exchange programs, under the auspices of the Petroleum Committee of the Canadian General Standards Board and a similar program under the auspices of the American Society for Testing and Materials. The exchange programs are recognized as essential for quality control and assuring the consumer the highest standard of laboratory service. This laboratory also continues to be active in the work of the Canadian General Standards Board, Petroleum Committee and its subcommittees.

The *Industrial Chemistry Laboratory* performs an analytical and testing service for Alberta industries. The solution to a problem may include physical testing such as weather-ometer or standard ASTM tests or may include simple or complex chemical separation and analysis tests. Some of the problems encountered were the analysis of a gold plating solution that was seriously inhibiting the production of emblems commemorating the visit of Pope John Paul II to Alberta, the identification of an odor that was present in an upholstery material, the weatherometer and physical testing of coatings to be used for outdoor switch gearboxes. The laboratory also performed monthly environmental surveys for the fertilizer industry in Alberta.

The *Oil Sands Analytical Laboratory* provided analytical support and guidance to projects in the Oil Sands Research Program. It provided a range of specialized analytical services to other research programs in the Alberta Research Council, government departments and industry. It also coordinated inter-laboratory sample exchange programs in the analysis of oil sands and bitumen. The laboratory continued efforts to improve analytical methods related to the study and analysis of bitumen, oil sands and production fluids, and in developing new methods for characterization of bitumen and bitumen components. These efforts included studies of asphaltene and agglomeration and precipitation from different solutions of bitumen.

The *Sedimentation Analytical Laboratory* supported geological studies by preparation of 561 thin-sections of rock or sediment samples, 101 size analyses of sand, silt and clay and over 600 other sample

preparations. These were in support of studies in oil sands, mineral resources, sedimentary geology and Quaternary geology.

The *Soils Analytical Laboratory* is operated jointly by the Alberta Research Council and Agriculture Canada to provide analytical support for soil survey and research projects. The laboratory provided 25 000 analyses on 2000 soil samples in support of soil studies during the year.

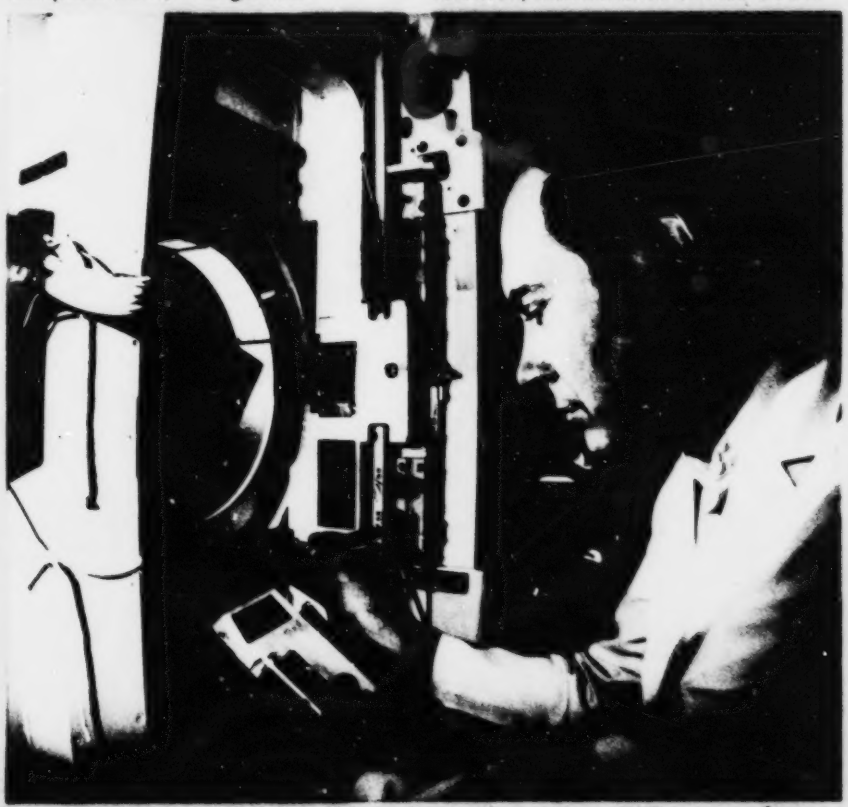
Computing support

Specialized computer systems support many of the research programs. To achieve the efficiency of sharing hardware, software and personnel, the Alberta Research Council has established a 15-node, in-house computer communications network. One project which provided support to research work was the software program written to allow the Gasoline and Oil Testing Laboratory to provide statistical reports for members of sample exchange groups. A second was the upgrading of an analysis program for the Sedimentation Analytical Laboratory. Other computer tools, with general application, were also further developed, including a program for plotting xy data and a general screen "data editor" which can be called from an application program and allows some typical editing functions as well as the writing of "user-friendly" data entry programs. A new geocartographic software package was introduced along with a number of utilities.

Staff played a major role in the development of strategic and operational computing plans for the Alberta Research Council which define the requirements for supporting the research programs.

Machine shop

The Machine Shop is an essential facility at the Alberta Research Council for building research apparatus to researchers' specifications. The Machine Shop was devoted largely to the coal research facilities at Nisku in the maintenance, construction and installation of high pressure and high temperature apparatus. It also continued to provide services for oil sands research, maintenance service on the weather radars in Red Deer, and apparatus for chemistry and industrial and engineering research projects.



Instrument Repair assisted in dismantling and moving a CAT scanner from a hospital to the oil sands research laboratories.

Instrument repair

Instrument Repair maintains a major portion of the analytical and electronic equipment in the Alberta Research Council. In the past year it continued to assist in the installation of the expanding network of in-house computers and terminals. The Ethernet system was installed and is being tested for future use in the Mill Woods facility. It also assisted in the maintenance of the network of monitoring stations connected with the Solar and Wind Energy Research Program. Over the past year it provided assistance to the forest products and plastics testing laboratories at the Parsons Property building. Instrument repair also assisted in the dismantling of the computer axial tomographic scanner (CAT) at the University Hospital, Edmonton, to be moved to Clover Bar for use in evaluating oil sands samples.

Graphic services

Cartography remained the main function of Graphic Services with emphasis on completing all the remaining geological maps covering the Precambrian Shield study area. Thirteen maps were printed. Graphic Services also completed 35 aggregate resource maps, 8 soil maps of various provincial parks and one hydrogeological map (Fort Chipewyan/Lake Claire). It also provided extensive photographic and graphic services for presentations, displays, technical reports and publications and continued to provide mechanical drafting services to oil sands research at Clover Bar and coal research at Nisku.

Human resources

Human Resources is responsible for providing support and advice to management and staff in the areas of employee and labor relations, recruitment and selection, compensation and pay, employee benefits, performance appraisals, staff development and training and occupational health. Human Resources focused on manpower planning, career development and specialized recruiting. Special attention was directed to funds

available through provincially sponsored work programs such as Priority Employment Program (PEP) and Summer Temporary Employee Program (STEP) and to funding through Natural Sciences and Engineering Research Council of Canada for undergraduate and post-graduate industrial research scholarships. Staff development and training focused on in-house courses dealing with research project management, computer literacy and introduction to the Research Council's computerized operating and datatrieve systems.

The Occupational Health Unit continued to expand the health assessment program and started in-house training for first aid and cardiopulmonary resuscitation. Occupational hygiene activities focused primarily on the Nisku site and included medical surveillance, a health hazard assessment, and environmental and personal monitoring. A general eye protection program was developed in conjunction with the Safety Office.

Financial services

Financial Services is responsible for planning, direction, coordination and control of the Alberta Research Council's financial assets and resources and the timely recording and reporting of all financial activity. Financial Services streamlined the fixed asset, project costing and reporting systems. It also spearheaded the preparation of an electronic data processing plan, leading to the acquisition and implementation of a new computerized financial management information system to meet the Alberta Research Council's present and foreseeable needs.

Safety

The Safety Office is responsible for ensuring that the Alberta Research Council meets its safety commitments with regard to federal and provincial health and safety regulations, by designing appropriate internal policies, regulations and standards. Safety managed the volunteer services of 174 staff members who acted as evacuation wardens or served on safety committees and emergency squads. Training for the emergency squads included industrial fire fighting courses at the Vermilion Fire School, and the Alberta Disaster Services basic rescue and H_2S alert course. The Alberta Research Council now has a total of 14 qualified industrial fire fighters. Major accomplishments included development and implementation of a radioactive materials and radiation emitting devices safety program acceptable to the Atomic Energy Control Board. Permission was given to issue internal radioisotope user permits under the authority of the Alberta Research Council consolidated radioisotope licence.

Editing and publications

Editing and Publications Sales provided editorial services, typesetting, design, layout and distribution of the Alberta Research Council's technical reports and other publications. Improvements in customer services included a part-time employee hired for the Calgary office, resulting in increased sales. A *Style Guide* for all staff members was completed. The guide contains information on English usage, production details and format information. The number of requests for technical reports almost doubled to nearly 20 000.

Public relations

In addition to assisting the line departments with their public relations requirements, Public Relations produces two newsletters to inform staff and the public about the Alberta Research Council's research activities. *Newsline*, intended primarily for staff, is also distributed to government departments and the news media. The Alberta Research Council *R & D* is designed to inform and encourage industry to avail themselves of the expertise available in the Research Council. The Public Relations office coordinated special events such as a speech by the president to representatives of industry, university and news media in Lethbridge, and participated in public relations projects related to research in atmospheric sciences and to the Alberta Research Council's increased presence in Calgary.

Industrial fire fighting courses are part of the thorough training of emergency squads of staff volunteers throughout the Alberta Research Council.

Patents and Publications

Valid patents

Alkali recycling process for recovery of heavy oils and bitumens
Kessick, M.A.

Apparatus for progessively removing layers or burden from an inclined side of a cut
Owen, H.D. and T. Smith

Arc welding
Roen, R.A.

Article passing rotary seal
Jensen, E.J. and L.M. White

Beneficiation process for oxidized iron ore
Bertram, E.F., P. Harris and D.W. Myroniuk

By-pass system for transporting pipelined solid bodies around pumps
Berkowitz, N., R.A. Brown, E.J. Jensen and C. De Zeeuw

Co-processing of bitumen and coal to generate hydrocarbon liquids
Moschopedis, S.E. and S. Chakrabartty

Coal liquefaction process with oil sand bitumen derived solvent
Moschopedis, S.E.

Combination solvent injection-electric current application method for establishing fluid communication through heavy oil formation
Sacuta, A.

Continuous nitric acid oxidation of coal
Wood, J.C. and S.M. Creighton

Desulfurization of fluid coke
George, Z.M.

Direct coking of tar sand
Gadallah, F.

Drilling fluid composition
Moschopedis, S.E.

Enhanced oil recovery using electrical means
Sacuta, A.

Enhanced regeneration of poisoned claus alumina catalyst
George, Z.M.

Formation of coke from heavy crude oils in the presence of calcium carbonate
Kessick, M.A., Z.M. George and L.G. Schneider

HO_2 - H_2S membrane process Alberta helium patent
Pan, C.Y.

Hydrodesulfurization of coke
George, Z.M.

Hydrogen reduction of ferrous chloride
Rigg, T. and C.P. Gravenor

In situ formation of oil-in-water emulsion from bituminous oil deposits
Kessick, M.A., C.E. St. Denis and D.J. Currie

Lime addition to heavy crude oils prior to coking
Kessick, M.A., Z.M. George and L.G. Schneider

Metal complexes derived from semifluxional ligands
Sanger, A.

Method and apparatus for direction of solid bodies in pipeline transportation
Round, G.F.

Method and apparatus for pumping mixture
Kruyer, J.

Method and apparatus for transporting material in a pipeline
Hodgson, G.W., A.A. Roehl and M.E. Charles

Method for drying water-wet membranes
MacDonald, W. and C.Y. Pan

Method of rendering sour gases suitable for fuel and chemical uses
Creighton, S.M.

Method of feeding ruminants N-Glucosyl-N'-Hydroxymenthylurea
Elofson, R.M., L.P. Milligan, J. Wohllebe and M. Worsley

Method of preparation of coal for safe transport and storage
Berkowitz, N. and J.G. Speight

Method of transporting a substance along a pipeline
Kruyer, J.

Method of transporting oil and natural gas along a pipeline
Jensen, E.J., R.A.S. Brown and E.J. Wiggins

Pipeline transportation of heavy crude oil
Kessick, M.A. and C.E. St. Denis

Process for recovery of bitumen from tar sand
Kruyer, J.

Process for the extraction of bitumen from low grade oil sand
Kessick, M.A.

Process for the preparation of trans-3-formylbut-2-enenitrile
Chen, S.C. and J.M. MacTaggart

Production of metallurgical coke from oxidized coking coal
Ignasiak, B.

Regeneration process for poisoned claus alumina catalyst, including NaOH activation
George, Z.M.

Ruminant feed supplement and process for producing same
Diner, U. and R.M. Elofson

Ruminant feed of urea-furfural reaction product
Milligan, L.P., A.R. Robble, J.C. Wood and S.K. Chakrabartty

Seedling container
Creighton, S.M., D.L. Mitchell and W.C. Kay

Separation of coal-oil suspensions
Hodgson, G.W., G.F. Round and J. Kruyer

Solids transport in pipes
Mar, A.

Solubilization of humic acids lignites and coals
Moschopedis, S.E., E. Czakert and S.M. Creighton

Solvolysis of subbituminous coals in bitumen and/or heavy refinery residue
Moschopedis, S.E. et al.

SO_2 spray onto ensilage
Elofson, R.M.

The combined process for hydraulic mining, beneficiation and transportation of coals
Ignasiak, B.

Transition metal catalyst
Gadallah, F. and R.M. Elofson

Treatment of oil sands slimes and modified bitumen recovery process
Kessick, M.A.

Use of surfactants to improve oil recovery during steam flooding
Isaacs, E.E. and D.R. Prowse

1984 publications

Technical reports

Crop damage and sulfur emission trends in central Alberta
Wong, R. and M. English

Coal utilization options for future energy and feedstock supplies
du Plessis, M.P. and S.K. Chakrabartty

Nature of porosity in Alberta subbituminous coals
Parkash, S. et al.

Soil survey of Wabamun Lake Provincial Park study area and interpretation for recreational use
Greenlee, G.

Geology of the Ryan-Fletcher Lakes area, Alberta
Godfrey, J.

Hydrogeology of the Fort Chipewyan-Lake Claire area, Alberta
Ozoray, G.

Hydrogeology of the Wadlin Lake -Vermilion Chutes area, Alberta
Lytviak, A.

Spatial and temporal variations in groundwater chemistry of shallow aquifers in the Sand River area, Alberta
Wallick, E.

Articles

Reaction between rock matrix and injected fluids in Cold Lake oil sands -potential for formation damage
Contribution number 1239
Boon, J.

The stratigraphic position of Beaver River sandstone
Contribution number 1240
Fenton, M.

Selective agglomeration of metallurgical coal in stirred tanks and in a pipeline loop, part 1
Contribution number 1241
Ignasiak, B.

Coal quality, coal rank variation and its relation to reconstructed overburden, Upper Cretaceous and Tertiary plains coals, Alberta
Contribution number 1242
Nurkowski, J.R.

Streamwise and transverse ice loads on a circular load pile
Contribution number 1243
Huiskamp, W.

Application of ice engineering to bridge design standards
Contribution number 1244
Huiskamp, W.

An overview of weather modification activities in Alberta
Contribution number 1245
Deibert, D.

Alberta: 1984 update in the keystone coal industry manual
Contribution number 1246
Campbell, J.D.

Development of shoreline-shelf sand bodies in a Cretaceous epeiric sea deposit
Contribution number 1247
Cant, D.

Oxidation of *trans*-($RhCl(CO)(PPh_2R)_2$) (R = Et, Pr^iCH_2SPh) with $HgCl_2$ to form rhodium-mercury bonded complexes, and complexes of mercury (II) with phosphinoalkylthioethers or dithioethers
Contribution number 1248
Sanger, A.R.

The role of thermal decomposition in the degradation of organic compounds in the flame ionization detector
Contribution number 1249
Blades, A.

Quaternary events Canadian prairies: an example of correlation of quaternary chronologies
Contribution number 1250
Fenton, M.

Evaluation of ice bridges in the vicinity of Fort Chipewyan, Alberta
Contribution number 1251
Harrington, R.

Adsorption of SO_2 on alumunia catalyst studied by FTIR and ESR spectroscopy
Contribution number 1252
George, Z. M.

Ice-nucleating bacteria
Contribution number 1253
Kaneda, T.

Ice-nucleating bacteria isolated from the Ellerslie farm
Contribution number 1254
Kaneda, T.

Structural and sedimentological framework of Lower Cretaceous coal-bearing rocks in the Grande Cache area, Alberta
Contribution number 1255
Lagenberg, C.

A Cretaceous woodground: the teredolites ichnofacies
Contribution number 1256
Pemberton, G.

Tracemaking activities of crabs and their environmental significance: the ichnogenus psilonichnus
Contribution number 1257
Pemberton, G.

Morphological, ethological and environmental significance of the ichnogenera scoyenia and ancorichnus
Contribution number 1258
Pemberton, G.

Seeding effects on liquid water and ice crystal concentrations in Alberta cumulus clouds
Contribution number 1259
Kochtubajda, B.

Precipitation processes within an Alberta supercell hailstorm
Contribution number 1260
Krauss, T.W.

A relationship between hailstone size distribution and storm thermodynamics, and its application to the evaluation of seeding effects
Contribution number 1261
Cheng, L.

Alberta Geological Survey research
Contribution number 1262
Mossop, G.

Hydrogenation and hydroformylation reactions using binuclear diphosphie-bridged complexes of rhodium
Contribution number 1263
Sanger, A.R.

Polarographic redox potentials of diazotized polycyclic aromatic amines and the absolute electrode potentials
Contribution number 1264
Elofson, R.M.

Bitumen upgrading using synthesis gas and calcium oxide
Contribution number 1265
Gadallah, F.F.

Thermal breakup predictions on a regulated river
Contribution number 1266
Andres, D.

Liquefaction behaviour of Alberta subbituminous coals
Contribution number 1267
Ozum, B.

Optimization of coal liquefaction reactors
Contribution number 1268
Ozum, B.

Optimal control of a continuous two valves in series letdown flow system
Contribution number 1269
Ozum, B.

Some drilling and trenching methods used in sand and gravel exploration in Alberta
Contribution number 1270
Richardson, R.

Setting the scene for aggregate resource management in Alberta
Contribution number 1271
Edwards, W.A.D.

The aggregate inventory of Alberta
Contribution number 1272
Edwards, W.A.D.

Quaternary geology of the north Kaipara Barrier, Northland, New Zealand
Contribution number 1273
Richardson, R.

Bovine bile resistance increases *leuconostoc oenos* 44.40 viability upon lyophilization
Contribution number 1274
Kole, M.

Co-processing of Alberta subbituminous coal with oil sand bitumen
Contribution number 1275
Ozum, B.

Mineral transformations during the in situ recovery of bitumen from carbonate rock: a statistical - experimental study
Contribution number 1276
Boon, J.

Further investigations on the use of bitumen and heavy oils to process coal
Contribution number 1277
Moschopedis, S.E.

Chemistry in enhanced oil recovery -an overview
Contribution number 1278
Boon, J.

The polarization properties of fine scale reflectivity patterns within a severe storm
Contribution number 1279
Humphries, R.G.

A C-13 and N-15 NMR study of the *syn-anti*-isomerism of diazocyanides
Contribution number 1280
Cyr, N.

Interfacial free energies, zeta potentials and thromboresistance in bovine and ovine carotid arteries
Contribution number 1281
Gerson, D.

Two-stage subbituminous coal/bitumen liquefaction process
Contribution number 1282
Ignasiak, B.

Lithology-dependent diagenetic control of reservoir properties of conglomerates, Falher Member, Elmworth Field, Alberta
Contribution number 1283
Cant, D.J.

Summary of Quaternary stratigraphy and history, western Canada
Contribution number 1284
Fenton, M.

Application of till pebble lithology to the differentiation of glacial lobes in southern Alberta
Contribution number 1285
Shetsen, I.

Contribution of vitrinite macerals to the liquefaction of subbituminous coals
Contribution number 1286
Parkash, S.

Applications of agglomeration for upgrading low rank coals
Contribution number 1287
Ignasiak, B.

Direct reduction beneficiation process for fine grained iron ores
Contribution number 1288
Bertram, B.

Deformation associated with gypsum karst in the Salt River escarpment, northeastern Alberta
Contribution number 1289
Cruden, D.M.

Aircraft observations of snowfall from a synthetic crude oil plant plume
Contribution number 1290
Cheng, L.

Crystal structure of P-diethylaminobenzenediazon hexafluorophosphate
Contribution number 1291
Elofson, R.M.

A five-coordinate dicarbonyl rhodium (I) complex containing monohapto-2-diphenylphosphinothiophene: ($RhCl(CO)_2(DPT)_2$)
Contribution number 1292
Sanger, A.R.

An Upper Cretaceous fluvio-lacustrine coal-bearing sequence, Red Deer area, Alberta
Contribution number 1293
Nurkowski, J.R.

Propionate exchange reactions in methanogenic ecosystems
Contribution number 1294
Boone, D.R.

Time dependent relationships between liquid water, ice particle concentrations and sizes and silver content in seeded Alberta clouds
Contribution number 1295
Krauss, T.W.

Comparisions of silver with major chemical constituents in seeded and non-seeded cloud particulates in Alberta
Contribution number 1296
Krauss, T.W.

Depositional environments of coal and coal-bearing stata
Contribution number 1297
McCabe, P.J.

An overview of wind energy research by the Alberta Research Council including wind pumping preliminary test results
Contribution number 1298
Luft, H.B.

Effect of mineral transformation on porosity and permeability of dolomite rock during in situ recovery of bitumen: preliminary study
Contribution number 1299
Bird, G.

Thin-layer chromatography as an alternative to sara analysis of coal derived liquids
Contribution number 1300
Selucky, M.L.

Microbiology of soil and fertilizer nitrogen use efficiency
Contribution number 1301
Blades, A.T.

Changes in crop available nitrogen in soils in winter: mineralization, immobilization and denitrification
Contribution number 1302
Blades, A.T.

The use of nitrification inhibitors in attempts to improve the efficiency of plant uptake of fertilizer-N and soil mineral-N
Contribution number 1303
Blades, A.T.

Physico-chemical characterization of Athabasca oil sand and its significance to bitumen recovery
Contribution number 1304
Takamura, K.

Optimal reactor size distribution with fixed terminal constraints
Contribution number 1305
Ozum, B.

Petrography of low rank coals with reference to liquefaction potential
Contribution number 1306
Parkash, S.

Probable lobster burrows in the Cardium Formation (Upper Cretaceous) of southern Alberta, and comments on modern burrowing decapods
Contribution number 1307
Pemberton, G.

The glossifungites ichnofacies: modern examples from the Georgia coast, U.S.A.
Contribution number 1308
Pemberton, G.

Purification and properties of NADH- and NADPH- dependent p-hydroxybenzoate hydroxylase from corynebacterium cyclohexanicum
Contribution number 1309
Kaneda, T.

Book review, by Robert A. Meyers, ed., Coal Structure, 1982
Contribution number 1310
Ignasiak, B.

Bicyclization of aza-compounds by positive halid ions: 1 - Cyclic amines
Contribution number 1311
Gadallah, F.F.

Simulated distillation of coal derived liquids using combined gas chromatography - vacuum thermogravimetry
Contribution number 1312
Selucky, M.L.

Formation of an asymmetric Rh-Hg-Rh bridged complex
Contribution number 1313
Sanger, A.R.

Increased chitinase production by a non-pigmented mutant of *Serratia marcescens*
Contribution number 1314
Kole, M.M.

The Alberta Research Council's high pressure research laboratory at Nisku
Contribution number 1315
Aitchson, D.

Controls on hydrocarbon accumulation in glauconitic sandstone, Suffield heavy oil sands, southern Alberta
Contribution number 1316
Tilley, B.

Electrochemical pH control of saccharomyces cerevisiae batch cultures
Contribution number 1317
Thompson, B.

ALBERTA LEGISLATURE
OFFICE OF THE AUDITOR GENERAL

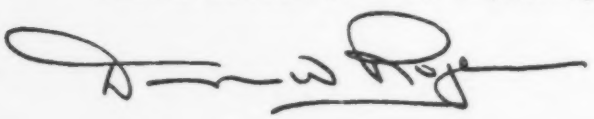
Auditor's Report

To the Board of Directors of
The Alberta Research Council

I have examined the balance sheet of the Alberta Research Council as at March 31, 1984 and the statement of revenue, expenditure and operating surplus for the year then ended. My examination was made in accordance with generally accepted auditing standards, and accordingly included such tests and other procedures as I considered necessary in the circumstances, except as explained in the following paragraph.

As disclosed in Note 4 to the financial statements, the Council has entered into research contracts which specify that the Council does not receive title to fixed assets purchased until completion of the contract or at the discretion of the sponsor. Since the Council did not identify those fixed assets to which it may not have title, I was unable to determine if any adjustment might be required to the balance sheet to adjust fixed assets and contributed surplus to reflect ownership of the assets.

In my opinion, except for the effect of adjustments, if any, which I might have determined to be necessary had I been able to identify assets to which the Council may not have title as described in the preceding paragraph, these financial statements present fairly the financial position of the Council as at March 31, 1984 and the results of its operations for the year then ended in accordance with the disclosed basis of accounting, considered appropriate in the circumstances, as described in Note 2 to the financial statements applied on a basis consistent with that of the preceding year.



F.C.A.
Auditor General

Edmonton, Alberta
November 5, 1984

STATEMENT A
ALBERTA RESEARCH COUNCIL
BALANCE SHEET
AS AT MARCH 31, 1984
(thousands of dollars)

Assets	1984	1983
Current:		
Cash	$ 8	$ 8
Deposits in trust (Note 3)	5,595	5,301
Accounts receivable	3,936	4,254
Prepaid expenses	386	48
Advances to joint ventures	553	182
	10,478	9,793
Other:		
Government of Canada and Provincial bonds, at cost	-	8
Fixed:		
Equipment (Note 4)	22,979	19,355
	33,457	29,156
Trust Fund:		
Deposits in trust (Note 3)	594	2,117
	$34,051	$31,273

Liabilities and Surplus	1984	1983
Current:		
Accounts payable	$ 2,333	$ 3,813
Deferred contract revenue	1,371	459
Obligation under capital lease (Note 5)	78	66
Advances payable, Province of Alberta	-	150
	3,782	4,488
Non-current:		
Obligation under capital lease (Note 5)	157	235
Equity:		
Contributed surplus	22,744	19,054
Operating surplus, Statement B	6,774	5,379
	29,518	24,433
	33,457	29,156
Trust Fund:		
Trust liability (Note 6)	594	2,117
	$34,051	$31,273

The accompanying notes are part of these financial statements.

STATEMENT B

ALBERTA RESEARCH COUNCIL
STATEMENT OF REVENUE, EXPENDITURE AND OPERATING SURPLUS
FOR THE YEAR ENDED MARCH 31, 1984
(thousands of dollars)

Revenue	**1984**	1983
Grant from Province of Alberta, Department of Executive Council (Note 7)	**$19,753**	$18,951
Contract revenue	**19,015**	18,276
	38,768	37,227
Expenditure		
Natural resources division	**11,165**	10,529
Energy resources division	**10,932**	11,253
Industrial and engineering research division	**5,842**	5,412
Frontier sciences division	**4,378**	3,103
Administrative division	**4,230**	3,641
Executive offices	**826**	797
	37,373	34,735
Excess of revenue over expenditure for the year	**1,395**	2,492
Operating surplus at beginning of year	**5,379**	2,887
Operating surplus at end of year	**$6,774**	$5,379

ALBERTA RESEARCH COUNCIL
NOTES TO THE FINANCIAL STATEMENTS
MARCH 31, 1984

Note 1 Authority

The Alberta Research Council operates under the authority of the Alberta Research Council Act, Chapter A 35.1, Statutes of Alberta 1981.

Note 2 Summary of Significant Accounting Policies and Reporting Practices

(a) General: These financial statements have been prepared in accordance with generally accepted accounting principles except that no provision for depreciation on fixed assets has been made. Purchases of operating fixed assets are charged to operations in the year and are shown on the balance sheet at original cost or at estimated cost with the offsetting credit to contributed surplus.

(b) Capital Lease: Assets acquired under capital leases, which transfer to the Council substantially all the benefits and risks incident to ownerhsip of the assets, are initially recorded as fixed assets at cost and the related lease obligations are recorded as liabilities. The lease obligations are reduced and contributed surplus increased by a corresponding amount over the lease term as lease payments are made.

(c) Advances to Joint Ventures: Advances to joint ventures are recorded as assets of the Council. The asset is reduced and a corresponding charge is made to expenditure for the Council's share of joint venture expenses.

(d) Occupancy and Office Furniture Expenditure: Occupancy and office furniture have been provided by the Province of Alberta at no cost and are not reflected in these financial statements.

(e) Patents: Expenditures for patents owned by the Council as a result of research activity are not capitalized due to the intangible nature of assets that may accrue to the Council.

(f) Investment: The Council is a majority shareholder of Alberta Helium Ltd. This company was formed to conduct research and its only significant asset is a helium recovery pilot plant which presently is not operating. The Council's equity in the company is not reflected in these financial statements.

(g) Changes in Financial Position: A statement of changes in financial position is not provided as disclosure in these financial statements is considered to be adequate.

Note 3 Deposits in Trust

Deposits in trust consist of deposits in the Consolidated Cash Investment Trust Fund of the Province of Alberta. In 1983, deposits in trust consisted of deposits in the General Trust Fund of the Province of Alberta.

Note 4 Fixed Assets

Fixed assets purchased subsequent to April 1, 1981 have been valued at cost. Those purchased prior to April 1, 1981 have been valued at estimated cost by the Council.

	1984	1983
Balance at beginning of year	**$19,355,537**	$15,157,087
Additions at cost	**3,623,247**	4,868,005
	22,978,784	20,025,092
Write-off	**-**	669,555
Balance at end of year	**$22,978,784**	$19,355,537

Included in fixed assets are certain fixed assets purchased as a result of research contracts which specify that the Council does not receive title to the fixed assets purchased until completion of the contract or at the discretion of the sponsor.

The difference between contributed surplus and fixed assets as disclosed on the balance sheet is represented by an obligation under capital lease.

Note 5 Obligation under Capital Lease

The following is a schedule of future lease payments under the capital lease together with the balance of obligation under capital lease.

Year ending March 31	
1985	$121,698
1986	186,978
	308,676
Less: Interest	73,353
Balance of the obligation	235,323
Less: Current portion	78,046
	$157,277

Note 6 Trust Liability

Trust funds are contributions received from other government departments under research agency agreements which specify the Council administer the contributions and provide accounting services.

	1984	1983
Balance at beginning of year	$ 2,116,503	$ 660,341
Contributions	2,003,271	4,700,721
	4,119,774	5,361,062
Expenditure	3,526,070	3,244,559
Balance at end of year	$ 593,704	$ 2,116,503

Note 7 Grant from the Province of Alberta

In addition to the grant of $19,753,000, the Council received $197,000 from the Province of Alberta for the operation of the Office of Science and Technology. This amount, net of expenditure, is included in the Trust Fund.

Note 8 Contingent Liabilities

The Council is a defendant in a number of legal proceedings. Claims against the Council in these proceedings, which have not been reflected in the accounts, amounted to $500,000 as at March 31, 1984. Subsequent to the year end, further claims totalling $386,000 were received. While the ultimate outcome of these proceedings cannot be predicted at this time, it is the opinion of management that the disposition of these cases will have a minor effect on the financial position of the Council.

Note 9 Comparative Figures

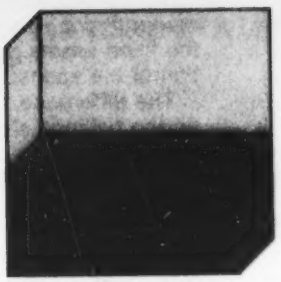
The 1983 figures have been restated where necessary to conform to 1984 presentation.

Note 10 Approval of Financial Statements

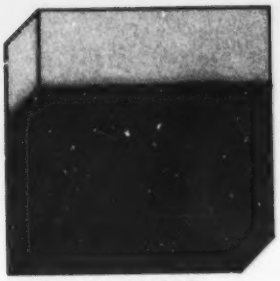
These financial statements were reviewed by management on November 5, 1984 and recommended to the Board for approval.

Actual Cost by Major Research Activity
For the Year Ended
March 31, 1984 ($000)

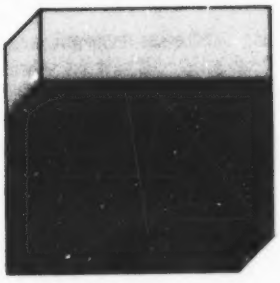
Natural Resources	$ 6,729 (G)	
	$ 6,127 (C)	
	$12,856	
Oil Sands	$ 2,583 (G)	
	$ 5,359 (C)	
	$ 7,942	
Coal	$ 1,428 (G)	
	$ 3,289 (C)	
	$ 4,717	
Industrial & Engineering	$ 4,204 (G)	
	$ 2,628 (C)	
	$ 6,832	
Frontier Sciences	$ 4,809 (G)	
	$ 217 (C)	
	$ 5,026	
	$37,373	



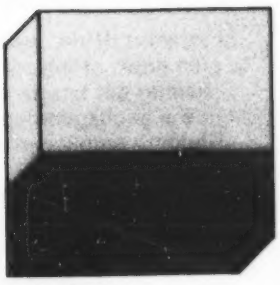
Natural Resources $12,856



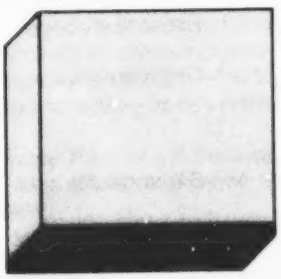
Oil Sands $7,942



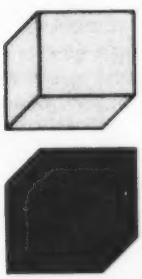
Coal $4,717



Industrial & Engineering $6,832



Frontier Sciences $5,026

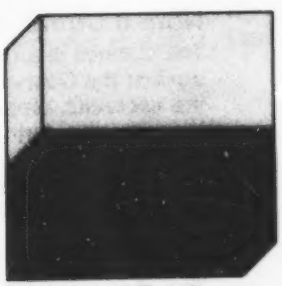


Sources of Funds ($000)

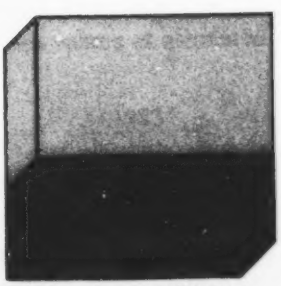
- Government Grant . . . . . $ 19,753 (51%)
- Contracts . . . . . $ 19,015 (49%)

Expenditures ($000)

- Manpower . . . . . $ 23,039 (62%)
- Supplies & Services . . . . . $ 10,633 (28%)
- Fixed Assets . . . . . $ 3,701 (10%)



Sources of Funds ($000)



Expenditures ($000)

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Minister of Economic Development

THE HONORABLE D. JOHNSTON
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Consulting engineer, Edmonton

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DR. R.W. STEWART[1,2]
President, Alberta Research Council, Edmonton

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[2]Salary schedule advisory committee

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Vice-President, Industrial & Engineering Research Division
and Regional Vice-President, southern Alberta

The Executive Offices are located at
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Edmonton, Alberta
Canada, T6H 5R7
tel. (403) 438-1666

Calgary Office:
250 Foothills Professional Building
1620-29 Street N.W.
Calgary, Alberta
Canada, T2N 4L7
tel. (403) 282-9136

Alberta Research Council Staff, 1984

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*1 November 1984

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Technical Staff: G. BERLINGO; V. CELINO; M. DANYSH; A.R. EWANCHUK; B. HUNT; B. LAYDON; D. MCALPINE; R. S. RIVENS.

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Supervisor: J.A. KINESEWICH.
Technical Staff: K. CROFT; J.J. YOUNG.

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Secretarial Staff: D.L. JACKSON.

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